THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. XC. No. 2196.] LONDON, JUNE 13, 1905. [57TH YEAR. PRICE 6d.

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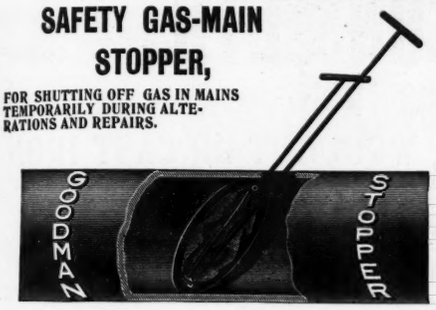

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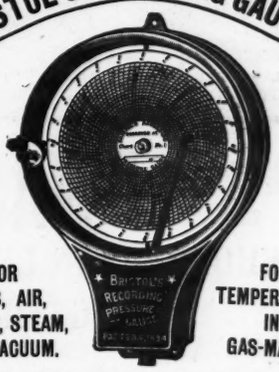

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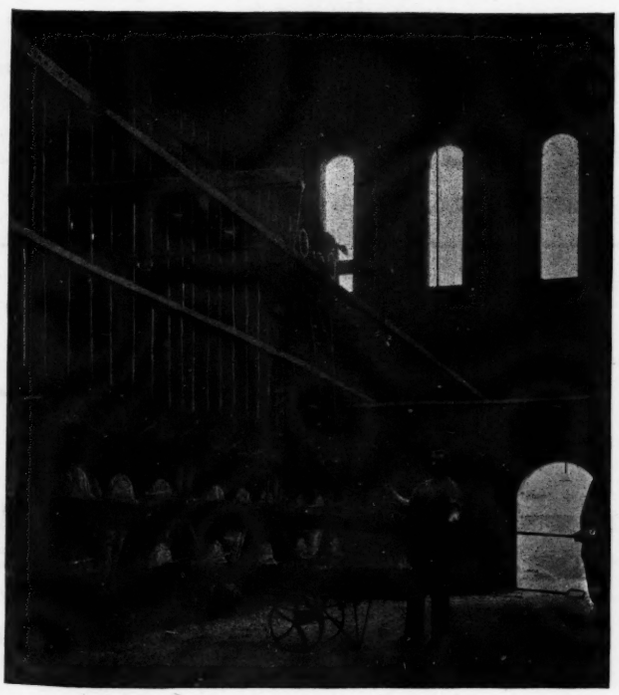

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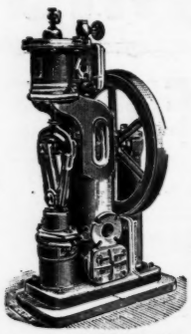

Fig. 705. "SINGLE RAM" STEAM-PUMP.

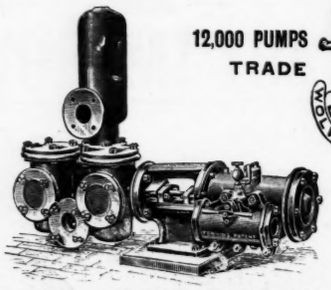

Fig. 598. "CORNISH" STEAM-PUMP FOR BOILER FEEDING, &c.

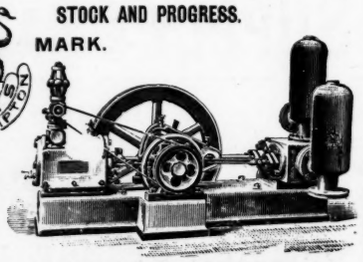

Fig. 685. "RELIABLE" STEAM-PUMP FOR TAR AND THICK FLUIDS.

Fig. 712. "DOUBLE-RAM" STEAM-PUMP.

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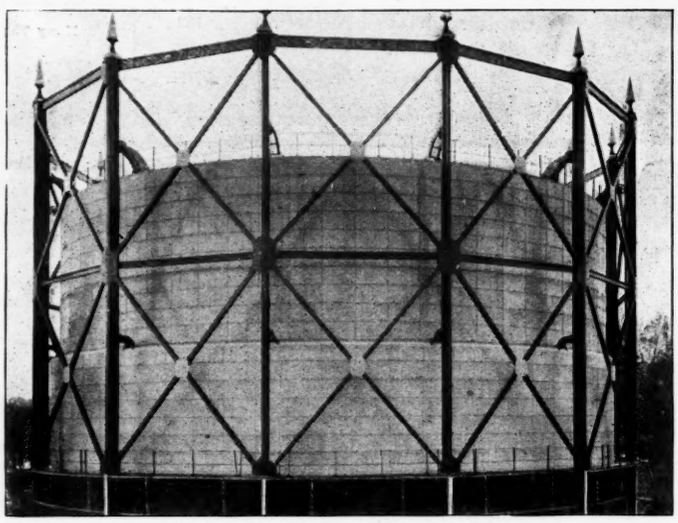

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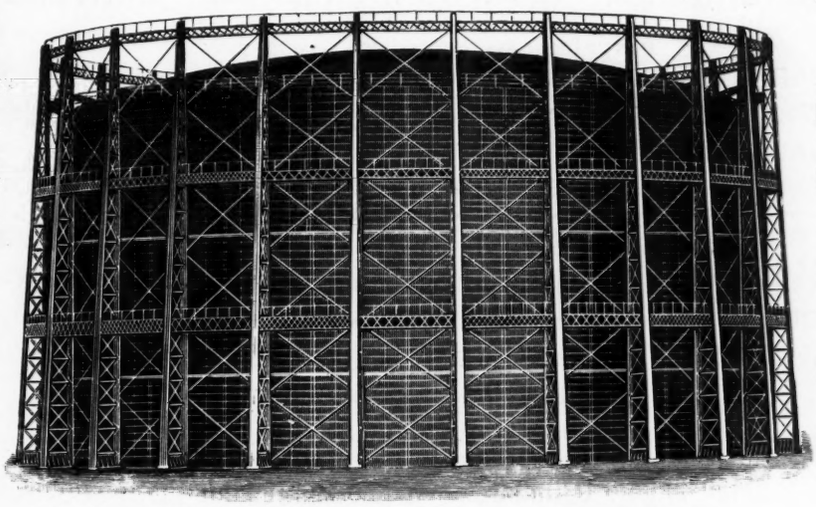

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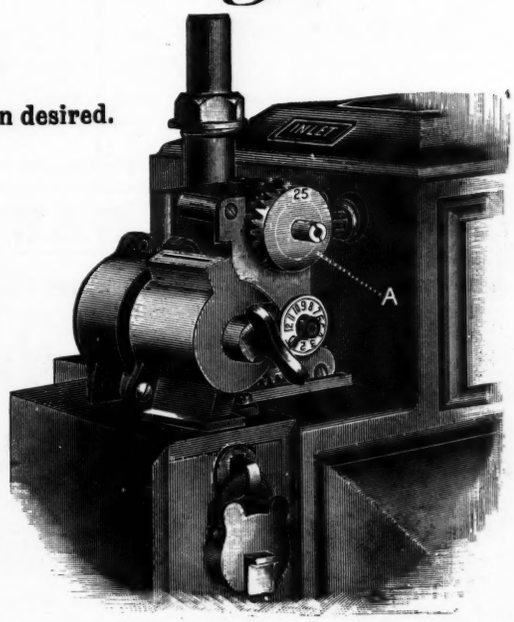

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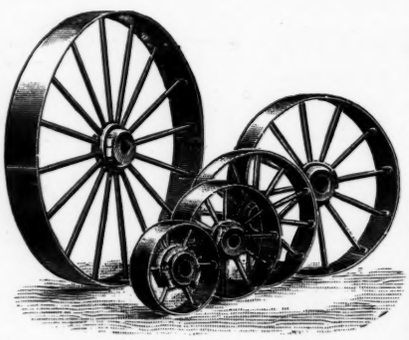

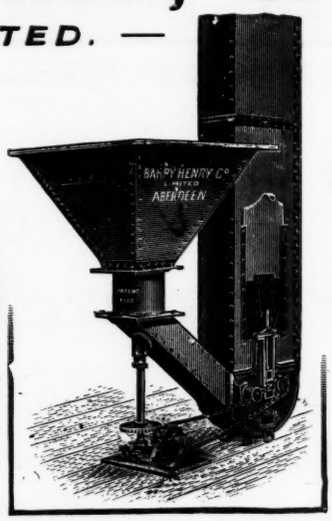

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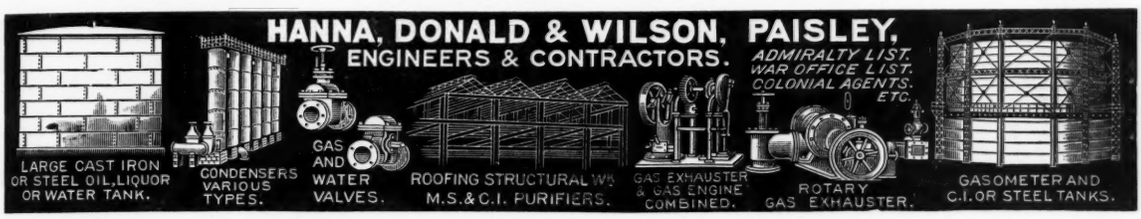
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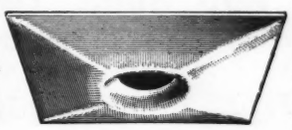

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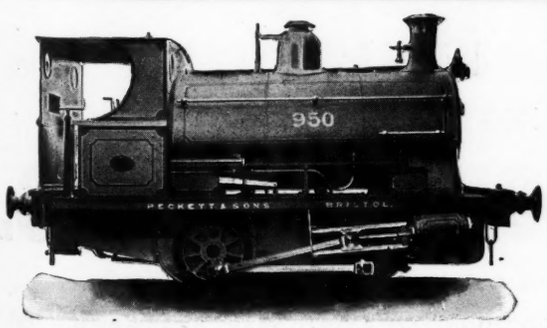

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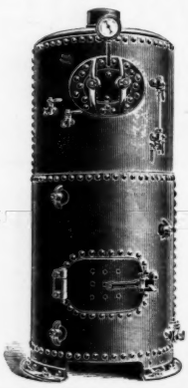

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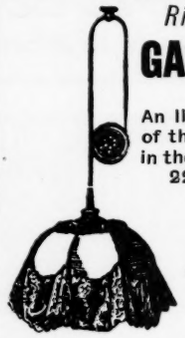

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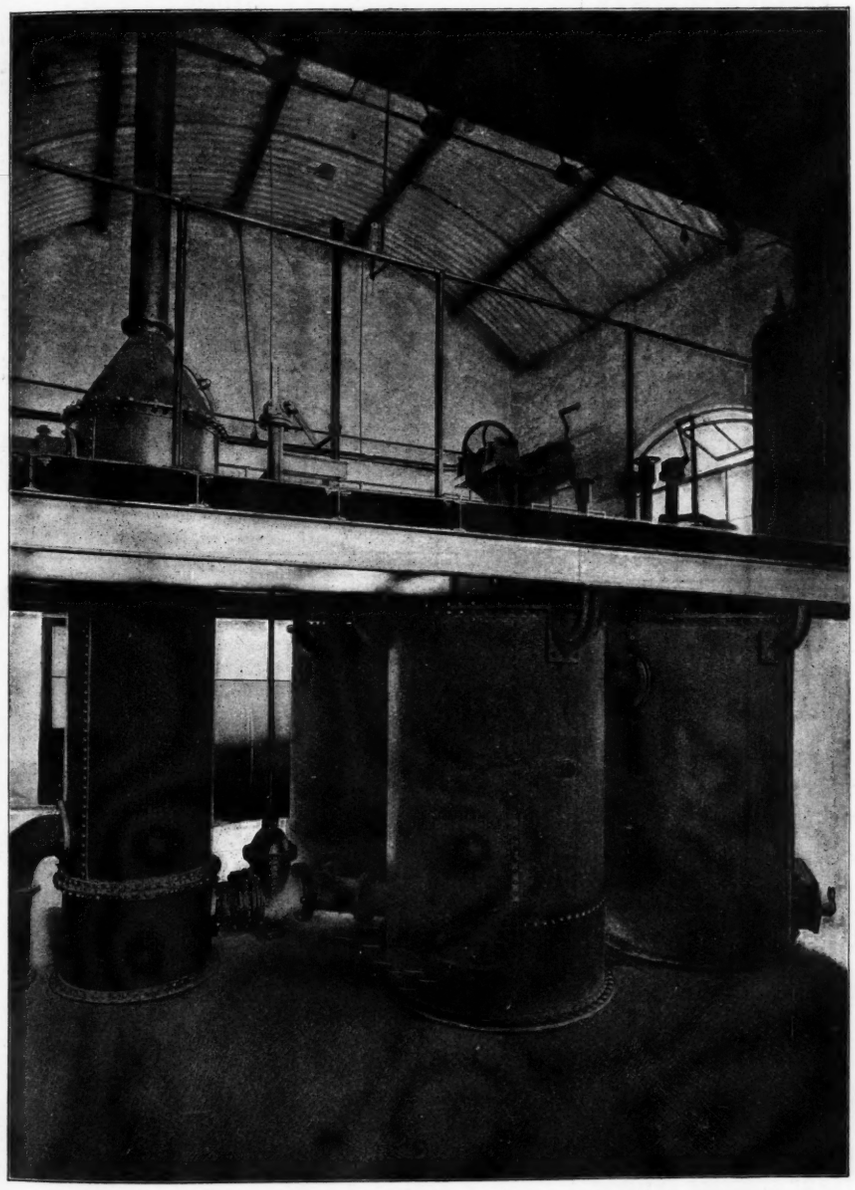

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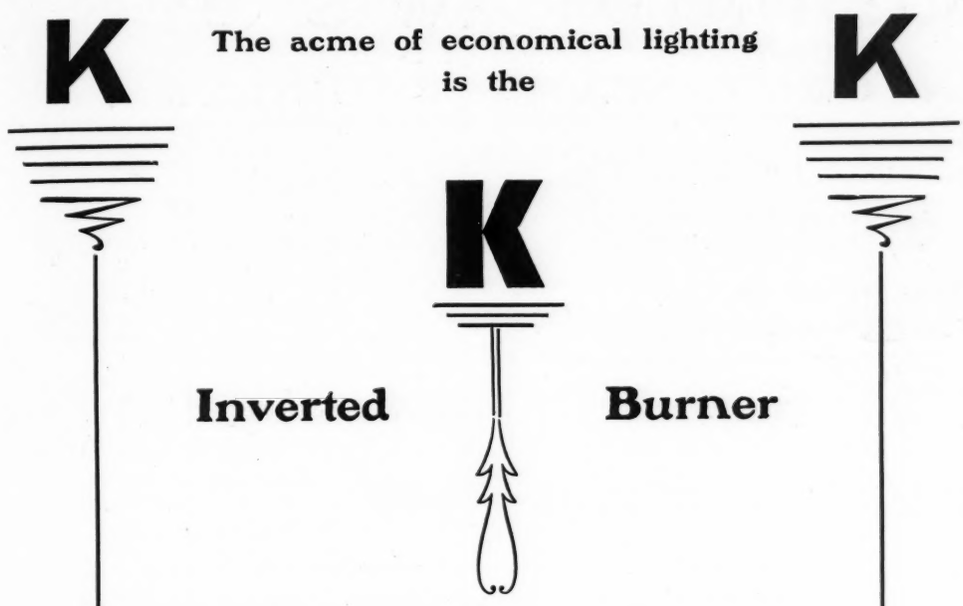

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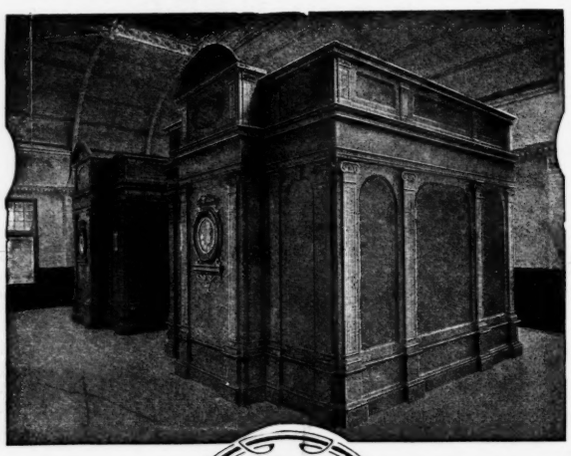

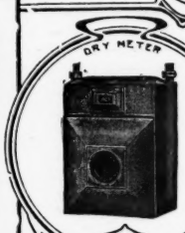

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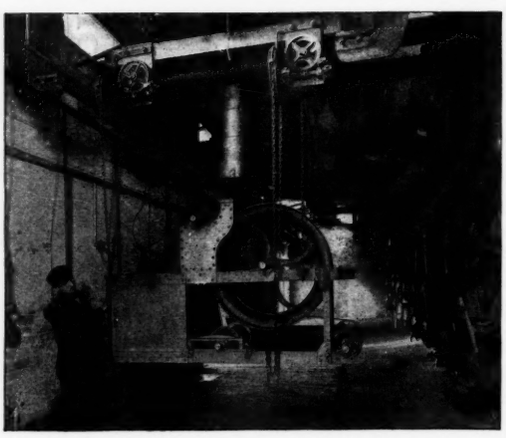

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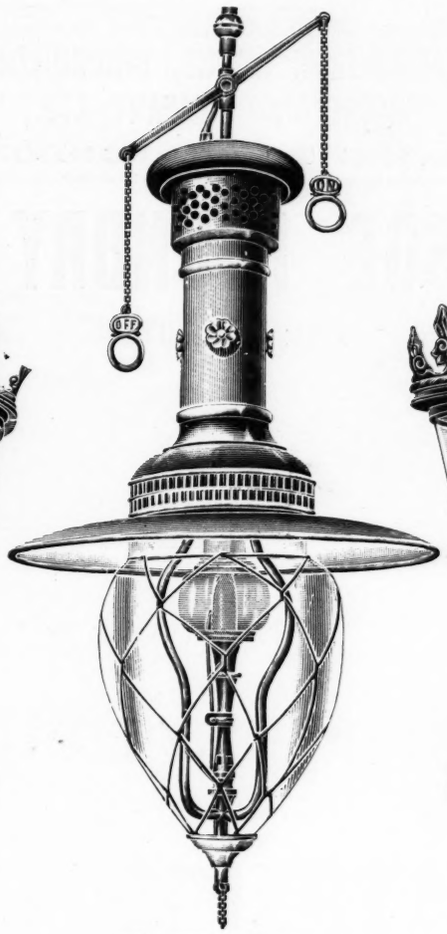

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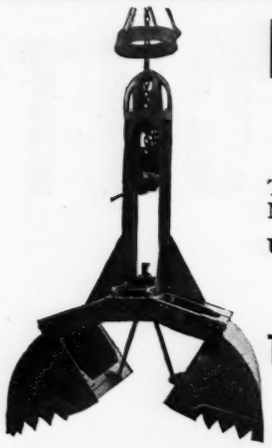

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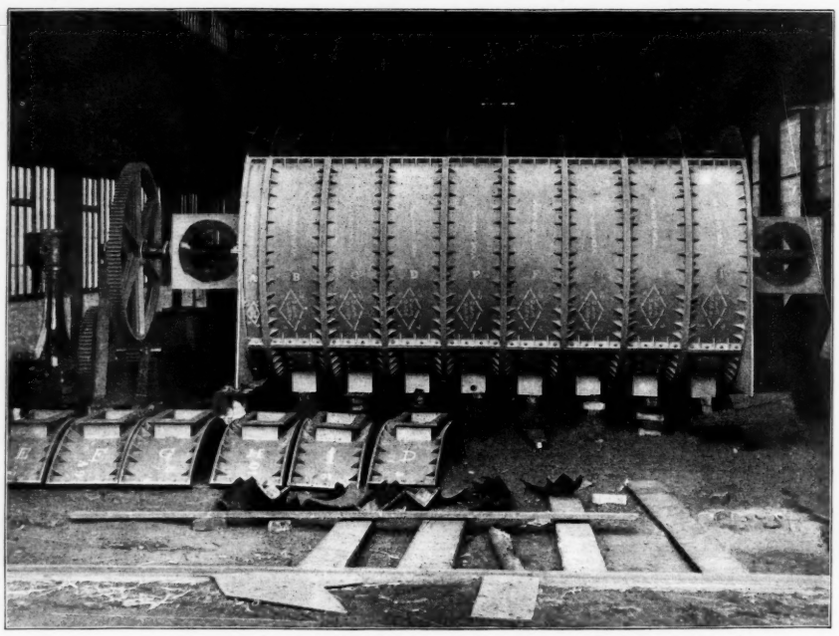

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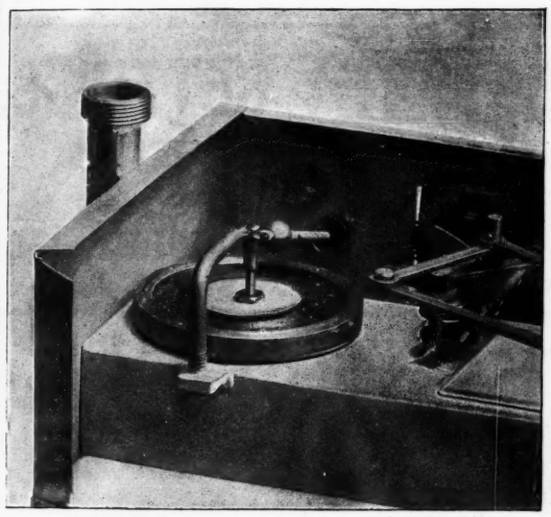

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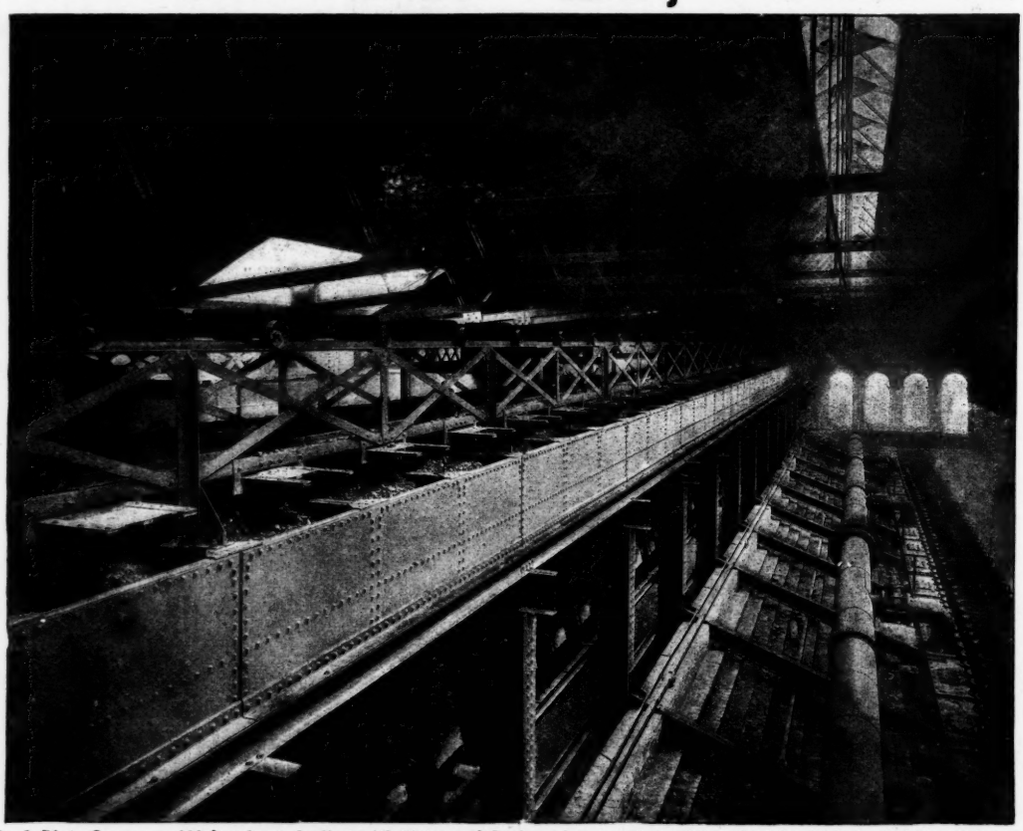

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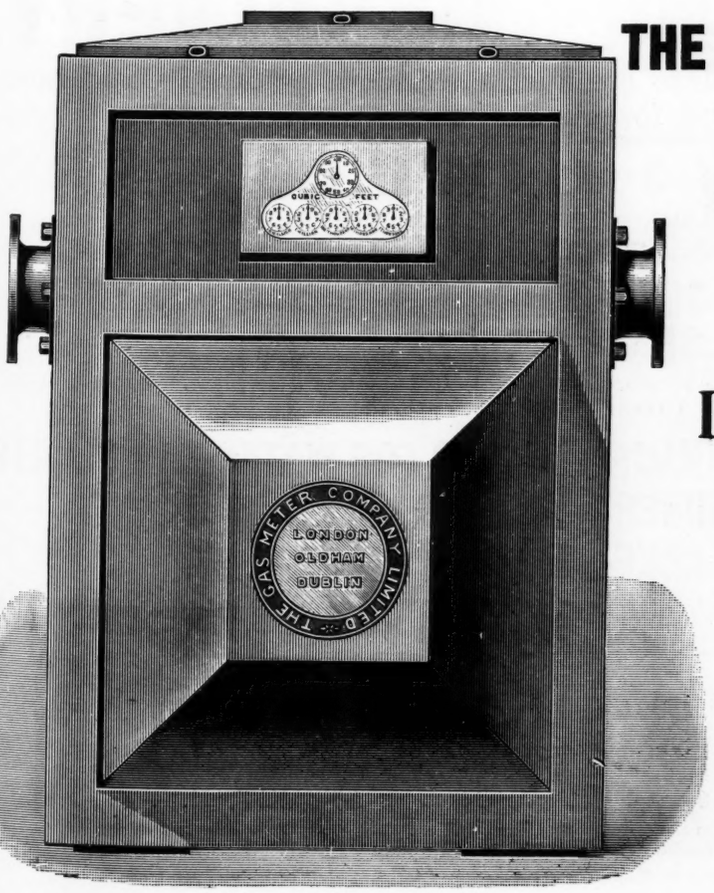

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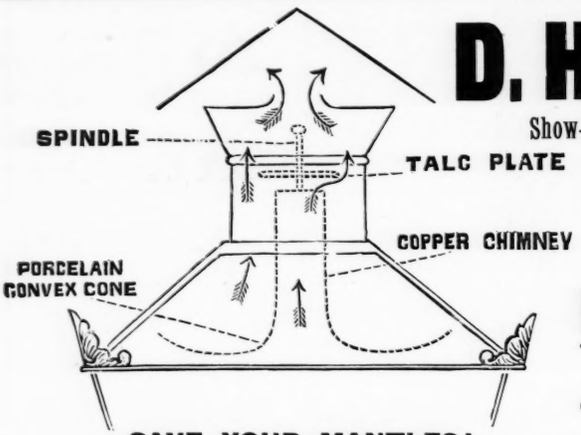

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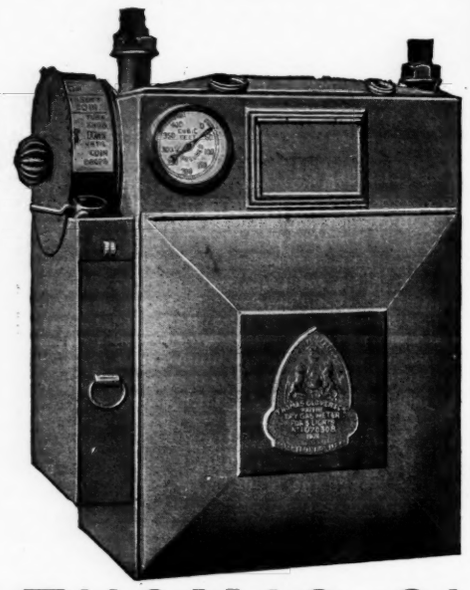

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VOL. XC., No. 2196.—TUESDAY, JUNE 13, 1905.

EDITORIAL NOTES—GAS, &c.

Parliament and Gas-Testing.

As was announced in last week's issue of the "JOURNAL," the Metropolitan Gas Companies have scored a signal victory over the forces of reaction. The London Gas Bill came before the Lords Committee, presided over by the Earl of Rosse, on Friday, the 2nd inst.; and the consideration of the testing clauses relating to the mode in which the illuminating power of the gas was to be determined, was continued the following Monday, when, after having heard all parties, and having also called before them Mr. Vernon Harcourt, the senior Gas Referee, the Chairman announced the decision of the Committee to be adverse to the provisions of the Bill, and favourable to the present method, as prescribed by the South Metropolitan Gas Company's Act of 1900, which they found to be satisfactory. This highly important pronouncement against the proposed re-enactment of the 5 cubic feet rate of consumption has given unbounded satisfaction to all who value the real progress of the gas industry, and the Gas Companies are to be heartily congratulated upon it.

As was to be expected, there has since been heard on all sides the familiar ejaculation, "Thank God, there is a "House of Lords." It is, indeed, quite true that on many occasions the common sense and acumen of this august body have been successfully appealed to against decisions of the Representative Chamber on Private Bills. But it is also true that the latter has similarly reversed decisions of the House of Lords. It is not, in such instances, a question of superior wisdom; the fact of the matter being that no case is quite lost until it has been twice lost, and that, however good a case may be, two opportunities of stating it are better than one. In the present instance, the opposition of the Companies to the proposed re-enactment of the 5 cubic feet rate of consumption gathered force from the rebuff which they experienced before Mr. Cawley's Committee in the House of Commons. It taught them the wisdom of relying upon a plain issue; and it rallied to them the support of all the recognized leaders of the gas industry. The Council of the Gas Institution took active steps to follow up their memorial to the Board of Trade; and, finding the latter indisposed to receive a deputation from them, took the only other course open to them of petitioning the House of Lords against the Bill. It is quite true that, in doing so, the Council took upon themselves, as was stated by Mr. Isaac Carr at the annual meeting, a greater amount of power than any previous Council in the history of the Institution had done. But the occasion demanded it; and the Institution have emphatically endorsed their action. It is greatly to be hoped that all the future Councils of that body will act with similar vigour and resource whenever the interests of the gas industry are at stake—as they were in the present instance. That much good resulted from the steps which were taken by the Council was apparent to all who watched the proceedings. In the Commons, the Companies had been told by the Committee: "We cannot "go behind the report of the Departmental Committee;" and not only was the memorial of the Institution to the Board of Trade not considered, but the President of the Institution, when offered by the Companies as a witness, was refused a hearing. Lord Rosse's Committee, on the other hand, while deciding that the petition of the Council to the House of Lords against the Bill was not formally before them, heard the case for the Companies without any reference to the Departmental Committee's report; and Mr. Daniel Irving (the ex-President of the Institution, as he must now be called) was permitted to testify to the opinion of the Institution upon the subject. This he did very clearly and emphatically—declaring, on behalf of the Institution, that it would be a retrograde action on the part of Parliament to put the proposed test on the Metropolitan Gas Companies. As witness followed witness for the latter, testifying in the most unequivocal manner to the inaccuracy of the proposed method of testing, as well as to the injustice that would be done by it, a feeling of confidence in the result grew, until it became almost a certainty on the admission by Mr. Vernon Harcourt, in answer to a member of the Committee, that the Companies' objection was a just one, and that the comparative values of different qualities of gases were given better by their method than by that proposed by the Bill of the London County Council.

What, then, was left for the promoters to do? Sir Ralph Littler, K.C., their leading Counsel, had been vainly endeavouring, in his cross-examinations, to obscure the issue by reference to other matters such as illuminating power in relation to price, which had nothing to do with the case; and he now wound up a long speech in which, he will perhaps forgive us for remarking, practically nothing was said, by offering, as a concession, that the size of the chimney to be used with the testing-burner should be fixed by the Gas Referees. This was, in effect, an admission of the justice of the Companies' case. They had contended—and their contention cannot be controverted—that adherence to the 5 cubic feet rate of consumption causes undue depreciation of the illuminating power of all gases below 16 candles owing to the excessive air supply. To a great extent, though not wholly, the air supply is controlled by the height and the diameter of the chimney used—particularly the former. If, therefore, the height be reduced, the draught is diminished, and the depreciating effect is made less apparent. In the "JOURNAL" for May 9, 1871 (Vol. XX., p. 352), there will be found the details of some experiments made on this very point by Mr. Charles Hunt. It would appear from these that the test-burner could be employed with chimneys varying in height from 6 in. to 3¾ in., without any greater variation in the proportionate values obtained than from 1·35 to 5·65 per cent. Assuming, however, that these were capable of confirmation under the somewhat altered circumstances of the present time (and, so far as can be recollected, there are no recent experiments on this subject), it is clear that any alteration in the size of the chimney for testing purposes lacks the simplicity and perhaps the accuracy of the fixed illumination method, as prescribed both by the Gas Referees and the South Metropolitan Gas Act, 1900. It is greatly to be hoped, therefore, that the latter will be maintained as an integral part of the Bill.

It is true that a position in some respects almost unprecedented has been created by the power which the latter body apparently possesses of withdrawing their Bill—a power which would have had no terrors at all for the Companies had they been able to keep their own Bill alive until the passing of this other Bill had become assured. It may still, however, be possible for them to reintroduce it; failing which, and the London County Council continuing obdurate, an appeal to the next session of Parliament could hardly fail of success. It cannot, however, be to the general interest that these matters should drag on year after year without any definite settlement being arrived at; and probably the London County Council will now recognize that quite sufficient public money has been wasted by them to no purpose whatever except to strengthen the hands of the Companies, and admit the futility of going any further.

Only a few days before, Mr. Edward Allen—the successor of Mr. William King at Liverpool (a member of the Departmental Committee whom the gas industry regard as largely responsible for the proposed re-enactment of the 5 cubic feet rate)—talked of this matter, at the meeting of the Institution, as a "nominal" grievance. Very naturally and rightly, the Institution declined to endorse this view, because they regard this method of testing for low-grade gas as an unfair, not to say dishonest one. But why should not the London County Council not regard it, with Mr. Allen, as of but "nominal"

importance? Neither they nor the public can have anything to gain by calling the 14-candle gas supplied by the South Metropolitan and Commercial Companies 13-candle, or even 12 or any lower denomination. They started on their quest, it is true, with the evident intention of getting, if they could, an additional candle out of the Companies. They failed in this, as they deserved to fail, and as they have also failed in all other points, possessing any substantial value, in their controversy with the Companies. Their over-reaching in this respect has proved, in fact, to be their undoing; for it led them to the Departmental Committee, which, as everybody knows, led them, much against their will, to the abolition of sulphur restrictions. And now their last cherished delusion has been destroyed; and they are face to face with the fact that the Bill which they introduced with a flourish of oratorical trumpets, for the purpose of "regulating" the Metropolitan Gas Companies, must either share the same fate as the one which they promoted for regulating the Sale of Bread, or be converted into a Bill for confirming the existing testing arrangements, and conferring upon the Gas Companies a greater amount of freedom than they have enjoyed since they were districted nearly half-a-century ago. Such is the Nemesis which has overtaken the latest attempt of the London County Council at gas legislation!

One very important question remains. In their struggle against this unjust recommendation of the Departmental Committee, the Metropolitan Gas Companies have had not only the strong sympathy, but also the active support—so far as this could be rendered—of practically the entire gas industry, many influential members of which, residing in distant parts of the Kingdom, have, at considerable personal inconvenience, taken part in the deliberations of the Council of the Institution upon the subject. They have done this because it is regarded as a matter of far wider importance than its relation to the Metropolis; and there is on all sides an earnest desire that the matter may now be settled, once and for all, by the establishment of a system of testing that can be accepted as giving comparable results for all qualities of common gas. It is fully recognized that this can only be done either by the South Metropolitan method of a fixed illumination, or else by a fixed height of flame such as that which was, as a matter of fact, proposed by the Institution in their memorial to the Board of Trade. The adjournment of the London Gas Bill, however, to the 4th of July is of itself suggestive of the possibility that exists of a compromise; and it would seem that this can only take the form either of an alteration in the dimensions of the chimney which has been already referred to, or an alteration in the burner. We venture to say emphatically that neither of these alternatives would be regarded as a satisfactory settlement by the gas industry generally, however it might suit the particular circumstances of one or other of the Metropolitan Gas Companies. To prescribe a burner for each different quality of gas, so that the results obtained shall bear some definite relation to each other, is felt on all sides to be a practical impossibility; and however tempted the Companies may be to consent to such a proposal, in order to obtain the other advantages of the Bill, their doing so would, we venture to say, be regarded as less than satisfactory by those who have hitherto supported them. It is on all accounts desirable that they should continue to present a united front with regard to it, especially since it is certain that, after the pronouncement of the Earl of Rosse's Committee, right must ultimately prevail. As Sir George Livesey truly remarked, during the discussion on this question at the recent meeting of the Institution of Gas Engineers, "Nothing is ever settled until it is settled right."

The Administration of the Alkali Acts.

To the average Englishman, a Blue Book does not usually present very light or entertaining reading; nor is the professional man particularly attracted to its contents, unless he is compelled by his special circumstances to consult them. The reason doubtless is because, as a rule, these productions are drawn up year after year on much the same lines, and, beyond statistical progress, there is little in the way of excursions into "fresh woods and pastures new" to arouse interest. This remark does not apply, however, to the Annual Reports of Mr. R. Forbes Carpenter, the Chief Inspector under the Alkali Acts, the latest of which is noticed in an article which appears in another part of the "JOURNAL." Those of our readers who have followed his work since he has held this position are aware that it is not confined to inspection merely, but is devoted in a large measure to investigation, in which he finds a hearty collaborator in his assistant, Mr. S. E. Linder. For example, he has taken up the analysis of ammoniacal liquors, and presented in his recent reports the results of his elaborate investigations. If these are "caviare to the general," they are none the less valuable as contributions to the literature of gas-works chemistry. In the report under notice, Mr. Linder has an interesting memorandum on the subject of the estimation of associated sulphur and cyanogen compounds by the Feld method; and the further studies of the Claus kiln reaction, to which attention has already been called in the "JOURNAL," are included. Opportunity will be taken to notice these researches, which are extraneous to the subject-matter of the report, at greater length in a future issue. Dealing now with the work of the Chief Inspector and the gentlemen associated with him who have charge of the several districts, it is satisfactory to find that though 5053 visits were paid and 4808 tests made, no proceedings had to be taken last year for the recovery of penalties for infraction of the limit clauses regulating the amount or intensity of escaping acid, or for failure to use the "best "practicable means" for preventing the exit of noxious or offensive gases. This fact furnishes striking proof of the desire of the managers of the works scheduled in the Acts to conduct them in such a way as to interfere as little as possible with the comfort of those whose lives are passed within them or in their immediate vicinity. As in previous reports, Mr. Carpenter gives the figures for the production of sulphate of ammonia in the United Kingdom. Though they show that the gas industry still contributes the largest quantity to the total bulk, they also reveal the fact that there has been practically no variation in the output for the past three years. What increase is recorded has come from producer gas and carbonizing works.

Continental Union Gas Company—
The Technical Director Question.

THE Chairman (Mr. Arthur Lucas) and Directors of the Continental Union Gas Company met the stockholders last Tuesday for the first time since the trial of the case which has involved the Company in such serious consequences. It is to the credit of the Chairman and Directors that they did not delay "facing the music" for a day longer than could possibly be avoided. The object of the meeting had to do with the modernizing of the Articles of Association; but immediately the special business had ended for the disposal of which the proprietors had been called together, the Chairman made a statement clearing himself and the Directors from the imputation that the whole truth was not told in Court regarding the action of the Board in not taking steps to look after the interests of the proprietors during the construction of the works at Milan. We have no desire to re-open this particular matter, nor to in the slightest degree cast doubt upon the accuracy of the Chairman. It is sufficient that the statement comes from Mr. Lucas. But this must be said, that, although the Directors themselves left Messrs. Graham, Morton, and Co. with a free hand, and the judgment of Mr. Justice Grantham shows that their confidence was not misplaced, it was a good thing for all concerned that the officials of the Company were so far faithful to their trust and duties [see Mr. Green's and Mr. Bourne's evidence] that they did, as a matter of fact, make constant inspections; and it would, as the event proves, have prevented a huge squandering of money in litigation if the Directors had themselves given instructions for special inspections and reports during the construction of the work.

The litigation is itself sufficient proof that a mistake was made, as the Directors would never have pursued the course they did in defending the action and making the counterclaim if they had taken the ordinary precaution of having the soundness and satisfactory condition of the work certified as it progressed. The first defensive measure which the Board own to in this matter is when, after the completion of the benches, an inspection was made outside when the whole of the interior construction—upon which, given honest treatment, the working entirely depends—had been closed to sight. Had there been a Technical Director on the Board, he would have known better than to have been a party to this act of ignorance, and yet he would have been able to give Messrs. Graham, Morton, and Co., all the

head they required. Therefore we say, in the interests of justice, it was a good thing that Mr. Bourne and Mr. Green made the inspections that they did. This, however, is now a matter of the past; and as from the mistakes of the past (as a stockholder put it at the meeting) guidance is obtained for the future, it may be anticipated that the Board are not likely to err again in this particular regard, as they confess to have done in this instance. If they do not, then so much the better for both the Company and their future contractors.

The Chairman and Directors gave the proprietors at the meeting ample latitude for expressing their views, though not on the merits or otherwise of the case which has brought the proprietors to the position at which they feel themselves, in their own interests, bound to review the Company's whole situation. With admirable good sense and feeling, the speakers in the discussion put the most unpleasant things they had to say in the most pleasant and courtly language; and there was a distinct endeavour to avoid anything that could appear to be personally disrespectful to any member of the Board. There was talk of mismanagement—mismanagement "unparalleled" in his fifty years' experience, Mr. Trewby described it; but the proceedings generally partook more of the nature of a conference where the proprietors offered a suggestion which it was considered would supply the deficiency that prevents the Board being regarded as a perfect composition for the direction of an undertaking in which so much depends for success upon a knowledge at the head of special works, methods, and requirements. One or two other proprietors thought the Directors should see whether the officials in responsible positions are equal to the times; but we question the competency of the Directors without an engineering representative on the Board—one who has lived (as it were) in the affairs of the Company—to decide the fitness or otherwise of their engineering staff. However, the first proposition is the more important. The proprietors suggested, not that any of the existing Directors should retire, but that they should be fortified by the addition to their number of a qualified gas engineer, seeing that it is on the engineering side of the business that the capital is spent. It is on that side the Board is weakest. It was delightful to hear Mr. Tendron naming his colleagues one after the other, and referring to their qualifications as managers of the affairs of gas companies. We admit the correctness of what he said in regard to them; but while those gentlemen have all special and valuable qualifications obtained from experience, there is not one of them who has had practical training in the technical work of a gas undertaking. The Directors, however, have deliberately set themselves—it is quite obvious both from Mr. Tendron's and the Chairman's remarks—against having a Technical Director. The Chairman himself said "as long as he had the honour to preside "over the Board, he would strenuously oppose—and it was "straighter for him to say so at once—the appointment of "an engineering Director (because he was an engineer) on "the Board." What hope can there be for a Company when such irrational (we may be pardoned for so regarding them in the light of past experiences) ideas prevail?

The objections raised to the inclusion of a technical adviser on the directorate, are extremely feeble and totally unsatisfactory. The only two members of the Board who trusted themselves to giving publicity to their views were those with the least experience of a Technical Director. Mr. Tendron is not a Director of a Gas Company on the Board of which there is a technical member; and Mr. Lucas's experience is confined to the Imperial Continental Gas Association. And we cannot consent to the inference that may be drawn from his remarks by many outside passing without an avowal of our own opinion that his experience on that Board cannot justify his conclusions. All the other Directors are associated with one or more gas administrations on which there is a technical member; and if they subscribe to the pronouncements on this subject of the Chairman and Mr. Tendron last Tuesday, then the shareholders of those other companies have from time to time been misinformed as to the helpfulness of the Technical Director. Mr. Walter Hunter (who practises in another branch of engineering), as a proprietor and as a Director of two Gas Companies on the Boards of which there are technical men, bore testimony quite the reverse of the Chairman's and Mr. Tendron's; he having seen "a great deal of good" come from the presence on those Boards of the technical members. We are well aware that there are even among gas engineers those dictatorial, egotistic individuals whose presence would not be desirable on any Board. But surely they do not represent the characteristics of all gas engineers; and surely too there is such a thing as ability to make a happy choice. So far as the officers of a Company are concerned, since this question of the Gas-Engineer Director was first raised by Sir George Livesey, without exception those officials who have had experience of Directors who, from practice, can appreciate their requirements and recommendations, also bear testimony to the usefulness they find in (as it were) having their works and office directly represented on the Board by one who has been where they are themselves. At the meeting last Tuesday, Mr. Trewby—himself a Gas Engineer of half-a-century's experience, and until recently Chief Engineer to the Gaslight and Coke Company—urged upon the Board the advisability of allowing a technical man to join in their counsels. And Mr. Trewby gives this advice with the experience before him of the advantage of having had upon the Board of the Gaslight and Coke Company men who have passed through the engineering and practical management of gas-works.

The weight of evidence is against the Directors of the Continental Union Gas Company; and we cannot bring ourselves to believe that those Directors who did not speak on Tuesday will be prepared to say that their convictions, founded upon their experience on the Boards of those other Companies that we have in mind, coincide with the Chairman's and Mr. Tendron's. It does not—especially at this time—come with good grace from the Board to oppose, and to threaten the proprietors with "strenuous opposition," in this matter; nor are their reasons sufficient or in any one respect conclusive. The appointment of a Consulting Engineer is not to be preferred to the Technical Director. The Consulting Engineer is only responsible to the Board. He is an officer in a superior position. His influence in the counsels of the Board is of an indifferent kind; and he has no vote. He is not in such close touch with the affairs of the concern as a Director. The intimacy with those affairs gained as a Director assists his judgment in technical matters, more especially in a concern whose business methods and needs ramify as do those of the Continental Union Gas Company. It comes to this: The very qualification that on a Board of an important Gas Company is of supreme importance (as the past history of this Company alone shows), the Directors will not have; and, with many of the proprietors, we cannot understand their aversion.

Protection for Municipal Traders.

In the course of an article under the above heading, the "Financial News" last Saturday week said some unkind things with regard to present-day municipal policy. The cause of the remarks was the debate which took place in the House of Commons the previous Thursday on the North-Eastern Railway Bill, which, among other things, seeks authority to run motor omnibuses. The Bill passed the Select Committee; but in the House it was sought to limit the Company's powers by providing that if the omnibuses traversed a district where there were municipal tramways, the Company should not pick up intermediate traffic. This does appear to be a somewhat large request, even for a local authority; but it does not overmuch astonish our contemporary, who has long expected such an attempt to "invest municipal enterprise with a sacrosanct character." The writer remarks that when municipalities are warned that, by indulging in trading they are involving the credit of the ratepayers, they pooh-pooh the idea; but when, in the ordinary course of business, a rival comes near, they at once begin to cry out that the property of the ratepayers is in danger. It is also pointed out that if municipal tramways are to be protected against chance competition by railway omnibuses, on the ground that the expenditure on tramways has been authorized by Parliament, it should logically follow that railways constructed under parliamentary authority should be protected against the competitive extension of municipal tramways, from which they are suffering severely at this moment. The article concludes with the very frank expression of opinion that if, with the initial aids of practically unlimited capital and an almost unlimited revenue from the rates, the municipalities cannot face ordinary competition, they had clearly better "abjure 'enterprise' and stick to their

drains." No doubt in some quarters there may be a tendency to pass over the opinions of the "Financial News" on the ground that it is an organ mainly interested in matters connected with private capital; but this is not sufficient to dispose of the arguments adduced. So far as the particular case of motor-omnibuses is concerned, it is not difficult to understand a desire by tram-owning local authorities to keep them out of their district where possible. Competition is seldom welcomed by a trader, be his business large or small, however beneficial it may be to the customer; and seeing the enormous amount of ratepayers' money that has been sunk in the purchase or laying down of tramway systems, it is difficult to contemplate with equanimity the possibility of successful competition by the vehicles of private companies. It seems a conflict of ratepayers' interests might here arise owing to the policy followed by the municipalities; for while it would undoubtedly be to the advantage of the ratepayer to be served with any cheaper and more convenient means of conveyance that private enterprise might have to offer, the advent of such a system might necessitate a drain on his pocket to meet the losses which would probably result on the working of the public tramway.

A Councillor and his Qualification.

Altrincham was last week the scene of a dispute of considerable interest to councillors in general—and to ratepayers as well. The scene of action was the Petty Sessions; and the principal character—the defendant—was a recently elected member of the District Council, who was summoned for recovery of a penalty for having acted in this capacity when disqualified. The legal qualifications of councillors cannot be called onerous, in view of the very extensive powers that are wielded by them. The Local Government Act of 1894 provides (section 23) that "a person shall not be qualified to be elected or to be a Councillor unless he is a parochial elector of some parish within the district or has during the whole of the twelve months preceding the election resided in the district." Section 46 of the same Act imposes a penalty for acting as a Councillor when disqualified. Sub-section 8 reads: "If any person acts when disqualified, or votes when prohibited under this section, he shall for each offence be liable on summary conviction to a fine not exceeding £20." The validity of the election itself was not called in question under the summons; but it was contended that the defendant did not possess either of the qualifications necessary to enable him to act as a member of the Council—he was not a parochial elector, and he did not reside within the district. The election took place in April; and the defendant persisted in acting as a Councillor after being duly warned by the Clerk that he did so at his peril. A technical point was raised with regard to the introduction of section 23, as the summons was taken out under section 46; but in order that the matter might be brought to a definite issue, the Magistrates amended the summons. The defence then fell back upon the argument that the Act only applied to a person who had actually been disqualified, and that penalties could not be proceeded for until the defendant had been disqualified for some specific reason. The defendant admitted having acted as a Councillor; and evidence was called to show that he was not on the list of parochial electors, his home being at Hale. He, however, maintained that he possessed a residential qualification as one of three joint tenants of a club at Altrincham, at which he occasionally spent the night, though there was no regular sleeping accommodation on the premises, and the legal right to occupy such space as existed was claimed also by the other two tenants. This ingenious plea did not succeed with the Bench, who found that defendant did not possess a residential qualification within the meaning of the Act. It was recognized, however, that he had been actuated by conscientious motives; and a heavy penalty was not asked for. Under these circumstances, the Magistrates inflicted a nominal fine of £1, to which were added the costs £7 5s. 6d., and £3 3s. advocate's fee. Taking all the facts into consideration, the case was not one in which a heavy penalty was called for; but, at the same time, the principle contended for in support of the summons is one that cannot be too strongly emphasized—that persons who administer local affairs should be drawn from the locality, so as to prevent the district being managed by individuals having no financial interest at stake. It may be mentioned that notice of appeal was given.

For Gas-Works Contractors and Manufacturers.

It will not be out of place here to indicate one or two matters appearing in the annual report of the National Electrical Manufacturers' Association, as they may be useful to the representative Committee who are considering the question of forming a similar Association for the contractors and manufacturers of the gas industry. The Committee, we believe, have held at least three meetings; and we take it that very shortly there will be an opportunity of referring to their recommendations. As to the Electrical Association, the report speaks of its incorporation, with the view of enlarging its sphere of usefulness. This is a point that we have before pressed upon the attention of the manufacturers and contractors of the gas industry—that their electrical compeers have found association so valuable that they have raised the status of their organization by this effectual means. Then we read in the report that the constant demands upon business firms for Christmas boxes, beanfeast, cricket club, and other contributions have become a general tax; and members are urged to refrain from lending their support to such applications. The "general tax" is not by any means peculiar to the electrical industry. However, the Committee of the Electrical Manufacturers' Association are going to deal with this matter more exhaustively before next Christmas. The Association have also got as far as the drafting of rules in connection with the establishment of a benevolent fund for the electrical industry. But of more direct value, from the business standpoint, are the efforts of the Association to obtain redress of certain grievances in the classification of electrical apparatus, and switchboards especially. These have been fruitful in securing certain amendments as to the classification and terms under which electrical goods are to be carried by railway companies, at their own or at owner's risk. Another matter which the Committee have been looking into is the retention of deposits on specifications for an indefinite period, and the payment of non-returnable fees; also the retention of money on executed contracts, which entails hardship by the unproductive locking up of capital. Some of these are matters upon which, in the case of certain not unimportant gas companies, gas-works contractors have a grievance. These are a few of the subjects dealt with in the report; and by no means the least in importance is that of the Electrical Exhibition which the Association initiated, and which is to be held at Olympia in September and October next. In reference to this exhibition, we learn from another source that the Local Government Board have notified the Willesden Borough Council that they are not aware of any legal authority enabling the Council to charge on the funds of their electrical undertaking expenditure in connection with the exhibition..

The Price of Gas in the South Suburban Company's District.—As this issue of the "JOURNAL" was going to press (earlier than usual on account of the holidays), we received a copy of a notification which has been circulated among the consumers of the South Suburban Gas Company to the effect that the Directors are proposing to restore the price of gas to 2s. 6d. per 1000 cubic feet, at which it stood before they ceased enriching the gas last year. The reduction then made to 2s. 5d. would have been followed in a short time by a further one, if the withdrawal of the illuminating power clauses of the Company's Bill had not been forced this session upon Sir George Livesey and his colleagues by the action of the London County Council and the Local Authorities, in trying to compel a system of testing that has been condemned by the highest authorities and by gas men throughout the country. Even now, "if the Local Authorities should be willing to agree that, pending the application to Parliament next session, enrichment shall be in abeyance, the Directors will gladly let the increase in the price of gas be also in abeyance; thereby giving to the consumers the money that would otherwise go for useless enrichment." The explanation of the Directors will be published in full next week.

Fire-Bricks and Fire-Clay in Norway.—A communication has been received at the Commercial Intelligence branch of the Board of Trade from H.M. Consul-General at Christiania (Viscount Melville) in the course of which it is stated that the Bergestad, Teglvœrk and Chamotte Fabrik, at Porsgrund, appears to be the only factory of any importance for fire-bricks in Norway. The total imports of fire-bricks in 1903 were about 6060 tons, of which about 4450 tons were from Sweden; of the total imports, some 48 tons were re-exported. No Norwegian fire-bricks were exported in that year. Of fire-clay, about 16,630 tons were imported in 1903, mostly into Christiania, Porsgrund, and Drammen. Of this total, 4613 tons came from the United Kingdom, 3353 tons from Denmark, 2694 tons from Germany, and 2213 tons from Belgium.

NOTES FROM WESTMINSTER.

The Gas-Testing Victory. The announcement which we were in a position to make in last Tuesday's "JOURNAL" (p. 663) as to the refusal by the House of Lords of the gas-testing clauses of the London County Council Bill will have given universal satisfaction in the gas industry—save perhaps at Widnes and Liverpool. Further allusion is made to the matter in our editorial columns to-day; and the report of last Monday's proceedings, which finished in such a conspicuous victory for the London Gas Companies and gas suppliers generally, appears in the "Parliamentary Intelligence." The forces representing the gas industry had been well marshalled for the final attack this session on the fixed 5 cubic feet rate for all qualities of gas, which was broken down by the South Metropolitan Act of 1900. But we cannot help thinking that Mr. Vernon Harcourt, the Senior Gas Referee, who was called by the Committee, did as much as anyone in assisting their Lordships to a right conclusion when he said:—

> I think the method of the South Metropolitan Company of burning gas, retaining the argand burner, at such a rate as to give a light of 16 candles, is preferable to burning at the rate of 5 cubic feet an hour. I consider their objection is just; and I think the proportions are given better by the method of the South Metropolitan Company than by the method of the Bill.

This statement will not be forgotten, though it is only reiterating, in different words, what Mr. Harcourt has said before. After it, however, the London County Council will hardly dare to approach Parliament again in an attempt to legalize the Quixotic proposal of the Departmental Committee. If they do, it must mean for them another miserable failure. It will be interesting to see the total of the Council's bills for parliamentary costs this session, and to compare them with the successes and defeats that they have sustained over their promotions and oppositions.

Non-Statutory Companies and Opposition. There seems to be some idea abroad that non-statutory companies deserve nothing but kicks at Westminster, and have no right to anything—not even to the right that a private individual possesses if he finds his interests are threatened by privately promoted parliamentary measures. Therefore we are glad that the Grangemouth Gas Company and the Hessle Gas Company—both non-statutory concerns—have been allowed *locus standi* in respect of Electric Lighting Provisional Orders affecting their respective districts. There are precedents for non-statutory companies being allowed *locus* in the case of gas supply; and several statutory gas companies have been permitted to appear against Electric Lighting Orders. In the case of a non-statutory gas company, the electricity competition of a local authority might be, if the authority choose to be unreasonable in curtailing the freedom of the gas company, a very serious matter for them. However, what the Grangemouth Gas Company want is, it was gathered from Mr. Courthope Munro, the insertion of the Bermondsey or Northumberland clause in the Council's Order. On the other hand, Mr. Freere, for the Hessle Gas Company, wants the clause now standing in the Hessle Order altered to coincide with the version of it that has been applied to the municipal wiring and fittings business in London, as projected by the County Council Bill—that is to say, they want the elimination of the words "so far as reasonably practicable," in order that the Council may not, in conducting their electrical business, shelter themselves, as they would otherwise be entitled to do, behind the statement that they are using their best endeavours in keeping a clean balance-sheet. For the first time in connection with a matter in which we are interested, Mr. Forbes Lancaster appeared (opposing the Grangemouth application) on his elevation to the dignity of King's Counsel. *Locus* was granted in both cases by the Court of Referees; and this will be a source of gratification to non-statutory companies. They want a little gratification occasionally, for they are hard-pressed, as a rule, when they get into the Committee Rooms. A report of the arguments in these applications was published last week.

Southport Water. There are one or two Water Bills which have been considered during the latter part of the sittings preceding the Whitsuntide recess, but of which the busy circumstances of the last few weeks in other directions have prevented due notice. The Southport, Birkdale, and West Lancashire Water Board Bill was one of them; and though it ran over some four sittings, the points in dispute were not of a character having very general interest. It was Lord Barnard's Committee who considered the Bill; and its intention is to give the Water Board authority to construct new works (including a pumping-station at Bickerstaffe), at an estimated cost of £106,400, and an additional £6000 for mains. It was in 1901 that the works of the old Water Company passed from them to the Local Authorities, and the Water Board was formed. From the figures given in the course of the hearing, there can be no doubt that the population and trade of the district urgently demand that the sources of supply shall be augmented. But the St. Helens Corporation, the West Lancashire Rural District Council, and the Skelmersdale District Council came to Westminster, and averred that the proposals of the Board would act very prejudicially on their interests. To aver and to prove are totally different things; and when Professor Boyd Dawkins, Mr. Eaton, and Mr. Charles Hawksley testified to the contrary, the Committee appeared to have had but little doubt that the proper thing for them to do was to tell St. Helens—as they did—that they had not proved their case. It seemed, indeed, to be the opinion of the Committee that the promoters had exercised every care in selecting the site for the well. Skelmersdale was also disposed of by the Board entering into a perpetual obligation to make good any deficiency proved to be due to their works, by supplying water to the Skelmersdale Council at the mere cost of pumping. The sinking of the new well having therefore been allowed, the remainder of the Bill was considered, in conjunction with the Formby Township Bill; it being claimed by the Water Board that, if Formby became an urban district, it should be liable, with other urban districts, to deficits on the water-rates. The Committee, however, were relieved from the necessity of settling the knotty point, by an agreement exempting Formby for ten years from bearing any share of the deficiency. The agreement appealed to the Committee as being a very proper one.

Llandrindod Wells Water. The District Council of Llandrindod Wells are faced by the necessity of providing, at the earliest possible time, an increased supply of water. Llandrindod Wells is a place very much like Skegness, a Bill concerning the water supply of which we were commenting upon only a few weeks since. The summer population far exceeds the normal; and the provision of water, under such circumstances, always constitutes a difficulty. In Llandrindod Wells, the summer population is quite three times that of the normal. We have referred to Skegness, where the conditions are to some extent similar; and it may be noted here that the Engineer responsible for both the schemes presented to Parliament for these two places was Mr. Percy Griffith, M.Inst.C.E. It was in 1901 that the Council promoted a Bill for the purchase of the Water Company's undertaking, and they then obtained their Bill practically on the strength of an alternative scheme. The present supply is pumped direct from the River Ithon, near the town; and the alternative scheme that the Council brought forward some four years ago was for taking water from a place called Careg-wiber. Apparently that scheme was a mistake, for it has since been abandoned, and the period for the compulsory purchase of land has expired. Mr. Griffith's scheme was entirely new—the source of supply being the River Chwefri, and necessitating a main about 10 miles long. The most difficult point of the scheme was that to provide a storage reservoir would entail a very heavy expenditure; and, as the quantity of water required was such an infinitesimal proportion of the flow of the stream, it was recommended that the water should be taken out of the stream without storage. This is not without precedent, though it is unusual. The estimated cost of the scheme was within £10,000; and the maximum needs of the district are about 122,000 gallons—being equal to 15 gallons per head by day for a population (including 6000 visitors) of 8000. It was not intended to take more than 150,000 gallons. Originally there was a great amount of opposition; but some indication of the "importance" of the matters raised by the opposition is afforded when it is said that only the Hereford Corporation and the Builth District Council were eventually represented before the Committee, presided over by Lord Brougham and Vaux, and that Hereford withdrew before the case was finished. The principal evidence in support of the scheme was furnished by Mr. Percy Griffith, Dr. Thresh, and Mr. Brough Taylor. Dr. Thresh asserted that he could not conceive of a better source of supply than could be obtained on the upper reaches of the river. Now it is a singular thing that, although the opposition of Builth only remained, their Lordships rejected the scheme, evidently being impressed by the argument of Mr. Rees (the Water Engineer called for the opposition) that he had never heard of a case of taking water from a stream without compensation water being given. All that the promoters required was one-third of the minimum flow.

The Tottenham Retort-House Contract.—With reference to the article on the new steel retort-house at Tottenham which appeared in the "JOURNAL" last week, the Engineer (Mr. A. E. Broadberry) has pointed out that the contract was entrusted to Messrs. C. & W. Walker after competition by them with several other firms. It should be explained that in the firm's letter advising us on the matter it was stated that the contract had been given to them by the Gas Company "direct;" and this was inadvertently construed as meaning "without tender."

Commercial Photometry.—In "Technics" this month, Mr. John F. Simmance appears as the author of an article on "Commercial Photometry." A second one is promised; and if it is as interesting as the first, the two will be worth not only reading but preserving. Mr. Simmance's qualification for writing on the subject is so well known that it would be superfluous to say anything here on that head. The "Flicker" photometer which he invented, in conjunction with Mr. Jaques Abady, to obviate difficulties and errors in testing lights of different colours, has been an important contribution to the means at disposal for securing a high degree of accuracy in light measurement.

THE GAS STOCK AND SHARE MARKET.

(For Stock and Share List, see p. 854.)

THE week just concluded on the Stock Exchange was a very quiet time. The prospect of an important Jewish holiday on Friday, a Christian one on the following Monday, and a closed House on the intervening Saturday was sufficient to keep business down to very moderate proportions. And the general slackness, combined with a little nervousness over M. Delcassé's resignation, the non-progress of peace prospects, and perhaps the bad weather, effectually gave things a dull tinge the first half of the week. But later on, the tendency became better, on confident rumours regarding Russia's attitude; and before the close there was a more comfortable feeling all round. In the Money Market, easy conditions became very marked, and they helped to induce a better feeling. Business in the Gas Market fell off in point of volume much the same as other departments were affected; but there was not any tendency in prices to shrink. There were not many or large changes in quotation, but they were sufficient to indicate a good firm tone in general. In Gaslight and Coke, the ordinary stock was moderately active, and changed hands at steady figures. The opening price, 99¾, was the lowest, and 100½ was the highest noted. The secured issues were firm; the preference being a half better, with business marked at prices ranging from 109 to 110. The maximum was done at 92 and 92½, and the debenture at 91. South Metropolitan was not much dealt in. Prices were firm at from 128½ to 129. The debenture was done at 91¾, and the quotation advanced a point. Commercials were neglected. In the Suburban and Provincial group, business was at a very reduced level; but wherever any was done the prices were satisfactory. Bournemouth 7 per cent. marked from 16⅝ to 17, Brentford preference 130½, and ditto debenture 107½. West Ham ordinary was done at 103, South Suburban ordinary at 121½, and ditto preference advanced a point without any transactions being marked in it. Tottenham "B" was done at par. The Continental Companies were not much dealt in, and were unchanged. Imperial marked 212 and 213, and ditto debenture 97. Union was done at from 111 to 111¾, and ditto preference at 141½. Europeans were left quiet again. Among undertakings in the remoter world, Bombay was done at 6¾ and 6 13/16, Cape Town at 17⅛, Melbourne 5 per cent. at 101¼, and ditto 4½ per cent. at 102 and 102¼. River Plate was proportionally higher, and business was done at from 11 13/16 to 12 1/16. Primitiva ordinary marked 6 1/16, ditto preference 5¾ and 5¼, and ditto debenture rose a point and marked 96. Monte Video marked 11¼ to 11⅞, and San Paulo 13 and 13⅛.

ELECTRIC LIGHTING MEMORANDA.

Gas and Electricity for Public Lighting—Hiding Material Information—Contractors and Municipal Wiring and Fittings—The Initial Expense of Consumers' Installations.

FOR light reading and diversion, the "Electrical Times" is the paper to which attention should be turned in moments of leisure. We are much indebted to our contemporary for the amusement it occasionally affords us; and, in its extreme good nature, it is very rarely that matter appears in its columns to which serious objection can be taken, even when dealing in flippant style with the comparative costs of incandescent gas lighting and electricity. There is, however, a paragraph in its issue of June 1, extending to only half-a-dozen lines, which is anything but honest. It refers to Newcastle-upon-Tyne, and states that "the City Council have been obtaining the costs of lighting the public lamps by electricity and intensified gas. The arc is shown to cost more, but to give more than double the amount of light of the intensified gas-lamps." In the first place, the writer of the paragraph apparently does not understand the difference between "intensified" or high-pressure gas and self-intensifying gas-lamps. But that is a trifle. The gas-lamps with which comparison has been made at Newcastle-upon-Tyne by Mr. George Lamb, the Corporation Lamp Inspector, are of the self-intensifying order, towards which, finding them so sufficient and economical in comparison with electric arc lamps, he inclines most favourably. It is the latter part of our contemporary's statement about which there is a want of frankness. "The arc is shown to cost more; but to give more than double the amount of light of the intensified gas-lamps." We gave some figures from Mr. Lamb's latest report in our news columns a fortnight since; but the lessons of that report were not then emphasized. When the figures are studied, it is found that the arcs cost more even when the same illuminating power is furnished by the self-intensifying gas-lamps, and (what is more to the credit of the latter) when they are rendering service for 983 hours more than the arc lamps during the year. Mr. Lamb is dealing with the comparative costs of lighting certain roads; and we cannot do better than extract, and put into tabular form, a few figures, to clearly define the position:—

	Electric Arc Lamps.		Self-Intensifying Gas-Lamps.
Cost per lamp	£12	..	£4 1 9
Total cost of lamps required	£1920	..	£764 7 3
Total illuminating power in candles	112,000	..	56,100
Hours of use	2793	..	3776

Therefore, it will be seen that the gas-lamps, for £1156 less than the electric arcs cost, are prepared to give half their illuminating power for about 1000 hours more. In other words, multiply the illuminating power of the gas-lamps by two, and we get the same illuminating power as would be given by the electric arcs. Multiply the cost of the gas-lamps by two, and we arrive at £1529, which shows a saving (though in use 1000 hours more) of £391, compared with the electric arcs. In addition to this, there would be a large capital sum to borrow for the electric arc lamps. Mr. Lamb also shows how the cost of gas lighting could be further reduced, if desired, by extinguishing half the gas-lamps at midnight, by the use of an automatic controller fitted to each lamp. How can the "Electrical Times" justify its statement? There is one other illustration while on this question of unfair reporting. It was recently stated that in a trial at Sheffield Lucas gas-lamps had been "defeated" by electric arcs. The electrical penman omitted the (to him) trivial point that the nominal illuminating power of the cluster of Lucas gas-lamps used in this test was 2100 candles each; while the nominal illuminating power of each electric arc was 5000 candles. In spite of this discrepancy in nominal candle power, the account which the Lucas lamps gave of themselves was not greatly inferior to that attained by the "5000-candle" power arcs.

While private enterprise always has our complete sympathy and support in its opposition to municipal trading, we cannot, as representing considerable ratepaying interests, but look with exceeding gratification upon the action of the House of Commons Committee who have decreed that those Metropolitan Borough Councils who take advantage of the wiring and fittings powers which the London County Council, with their usual officiousness, are just now seeking to obtain for them, shall so order their transactions in this matter that the outgoings shall be—not "as far as practicable," but completely covered by the income. It is the best alternative that the ratepayers can have to the refusal (which, of course, would be better) of the powers altogether. The electrical contractors would naturally prefer to be left without the competition of the municipalities; and we should also prefer to see the contractors with a free hand. But they are not so much concerned about the matter as ratepayers as about binding, through Parliament, the municipalities to do all the work through the local contractors. If Parliament confers wiring and fitting powers upon municipalities, we are not altogether convinced that such an arrangement as compelling the work to be done through the contractors is in the best interests of the ratepayers or of the electricity consumers. The money borrowed by the municipalities for the purpose is subject to repayment and interest; and in addition to earning that the contractors would want their fair profit. Circuitous journeys to an end are generally more costly than the direct route; and this is work that is not the same as (say) building or supplying special plant for use in a generating-station.

It seems to us with the proviso the Lords Committee have attached to the Metropolitan wiring and fittings clauses, the contractors of London will have an advantage in their competition with the municipalities. Electrical contractors in various parts of the country are grumbling hugely over the prices at, and the conditions under, which they are required to do work by municipalities; and certainly some of the prices offered do seem most unreasonable. But it will be open to the London contractors—if there is no change in the Upper House when the County Council Bill is again in Committee—to bring such sharp rivalry to bear on those authorities who are to conduct their wiring and fittings business on strictly business principles, that it will be their own fault if they do not secure a good share of it; and if the work is offered by the municipalities to the contractors, it will be for the latter to refuse it if it is not at a reasonable price, or open to tender. But trading even by tender between municipalities and electric lighting contractors seems to admit of questionable procedure, if the singular action of the Electricity Committee of the Swindon Corporation is a fair illustration. They have been indulging in the little game of levelling tenders up and down in order to get prices uniform—no doubt with the best of all intentions; but it is not the way that public business should be conducted. There is no doubt that under the old conditions of things, where the municipalities can play a loose game with the ratepayers' money in getting electric wiring and fittings into houses, that the contractors have suffered considerable loss, though anxious and alert for the business. But they cannot get the business on unequal terms. They speak of their defeat in the Commons as a serious catastrophe; and their Association are whipping the members up to bring their whole strength to bear on the County Council Bill when it reaches the Lords Committee. Their best course we are inclined to think is to direct their entire energy to getting the clauses swept from the Bill, or to leave them as they are. To go to Parliament and say, "We object to municipal trading, but if you think the municipalities should trade, compel them to spend their money through us" is playing a double game which is not likely to have any great success with Parliament. The choice should be between a complete overthrow of such trading powers, or the imposition of restriction to unfair competition.

It is an argument of those who defend municipal electricity purveyors in the matter of free wiring, that the reason the outlay on a number of municipal undertakings is out of all proportion to the number of consumers is secured because the people who do not actually own the houses they live in will not go to the expense of fitting them up for electric lighting. It is not surprising seeing

the cost of installing electricity; and on account of the cost, there is all the more reason why ratepayers should ensure that their money is not spent wastefully and unprofitably in wiring houses, the tenants of which may be of the roving class, or may even find electricity so expensive as to quickly renounce it. We took from an electrical contemporary, some little time since, a schedule of prices issued by the Borough of Hornsey to contractors for carrying out installations. In the schedule, the cost for wiring (using steel tube) is 15s. per point; and the cost gradually recedes until for wiring from 50 up to 100 points the price is down to 11s. 6d. per point. The figures are all 6d. per point less if "best American white wood" is used, instead of steel tube. The attention of the Engineer to the Council has been called to the "unreasonableness" of the prices, as it is a well-known fact that the larger a house is, the more it costs per point for wiring, in view of the fact that a large house requires more light per point than a small one; and this necessitates a greater expenditure in mains, &c. Take the case of a house requiring 50 points, and the expensiveness of installation is shown. The charge per point up to 50 points is 12s. 6d.; and this would total to £31 5s. There is another feature about the cost of electrical installation, and that is the wide uncertainty there appears to be about tenders. Just recently the Erith District Council invited tenders for wiring their car depots and workshops. There were sixteen tenders submitted, ranging between £200 15s. 6d. and £458—the highest figure being more than double the lowest. The Metropolitan Asylums Board, too, lately received nine offers for the installation of electric light, telephones, and fire alarms at the Southern Hospital. The tenders varied between £8400 and £11,600. The estimate of the Chief Engineer was £8500. Compared with incandescent gas lighting, the increased cost of electric lighting to consumers has been well established by experience; and the heavy initial cost of putting in electric fittings should not be overlooked by those who are educating people as to which is the most economical light.

THE PATENT OFFICE IN 1904.

WHATEVER may have been the case in other branches of industry, there is no sign in the Patent Office records of any wave of depression having overtaken the business of invention during the year 1904. The twenty-second report of Mr. C. N. Dalton, the Comptroller-General of Patents, Designs, and Trade Marks, shows that the number of applications was 29,678, compared with 28,853 the previous twelve months, or an increase of 2·8 per cent. At this rate, we shall not have to wait long for a fresh record; the highest number so far having been in 1897, when there were practically 31,000 applications. The largest number of applications received on any one day was 484 on Dec. 31—a fact which, it is remarked, seems to show that numbers of people were anxious to file their applications before the date when the new provisions as to examination under section 1 of the Patents Act, 1902, came into force. This, of course, was on Jan. 1 of the present year, in accordance with an order of the Board of Trade made last August.

The provisions of this section have already been referred to in the "JOURNAL," and in connection with the work of the Patent Office it is only necessary to allude to the preparations that have been necessary to enable the staff to fulfil the obligation now cast upon them—of ascertaining, in the case of every application which reaches the complete stage, whether the invention has been described or claimed in a complete specification published in this country during the preceding fifty years. The staff, which was increased during the year from 112 to 160 by the appointment of successive batches of new assistant examiners, was reorganized in October, and divided into 24 groups, each containing one examiner, one deputy examiner, and either five or six assistant examiners. In addition to their ordinary work, the examiners were largely employed last year in classifying and arranging specifications to facilitate search, and in training and instructing the new assistants; and besides this, great progress was made with the scheme of mounting on large cards the abridgments and drawings of existing specifications, so as to enable easy reference to be made to them. No less than 400,000 of these cards were prepared in 1903; and by the end of last year this number had been almost doubled, and divided into about 4500 separate search files. Fresh rules have been framed for regulating the procedure under the new section, and also for carrying into effect some of the resolutions passed at the Berne Conference. This conference, it may be mentioned, was a gathering of the heads of the Patent Offices of the countries forming the International Union for the Protection of Industrial Property. It was held at Berne in August, under the presidency of M. Morel, the Director of the Union, to discuss the best means of making uniform and simplifying certain administrative requirements in force in the different countries in connection with applications for patents and the registration of trade marks. These rules, which have received the signature of the President of the Board of Trade, are contained in an appendix to the report.

Owing to the inclusion of extraordinary items, the expenditure of the Patent Office last year showed an enormous increase, while the growth of revenue was comparatively trifling. There was, however, even thus a substantial credit balance as the result of the operations. The receipts from patent fees were £222,971, as compared with £223,504 in 1903. This was certainly a small decrease; but it was more than counterbalanced by an increase of £369 from designs fees, and of £3644 in the receipts on account of trade marks. The large increase in the latter item, it may be pointed out, was due to the fact that renewal fees for a further period of fourteen years became payable in 1904 upon the trade marks registered in 1876. The total receipts reached the very satisfactory sum of £252,417, as compared with £248,924. The expenditure, at £213,842, shows an increase of £89,787; but, as remarked, it includes several special amounts—the principal of these being £56,463 for expenditure incurred under the Public Buildings Expenses Act, 1903, for the purchase of a site for new Patent Office buildings. The amount received from the payment of renewal fees exhibits a slight falling off—£138,684, as against £139,864—and the influence of circumstances upon statistics is evidenced by the remark in the report that "this is due to the fact that the fifth year's renewal fees were payable upon the patents of 1900, which were below the normal number on account of the South African war."

The figures with regard to the origin of the applications for patents received last year are interesting. They show that, of the total of 29,678, no less than 18,116 came from England and Wales; the United States coming second with 3591, Germany next with 2807, and then Scotland with 1501, and France with 1095. The applications from England, Wales, and Scotland show large increases, and those from the United States and France were also more numerous; while among the countries with regard to which a falling off was experienced, no surprise will be felt at finding both Russia and Japan. Of the total number of 15,089 patents granted in 1904, 3051 were to persons resident in the United States, 2140 in Germany, and 778 in France. On the whole, the proportion of patents granted to foreigners evinces a slight tendency to diminish; the figures for the past five years having been 48·7, 50·3, 47·3, 47·4, and (1904) 46·5 per cent. As to the proportion of the total applications which finally became sealed patents, the report shows that 15,061, or 52·2 per cent. of the applications made in 1903, reached this stage; while 496, or 4·5 per cent., of the patents sealed upon applications made in 1891 were maintained for the full period of fourteen years. Considering the enormous number of applications made, these figures are no doubt satisfactory; but, at the same time, they speak eloquently of "disappointed hopes."

One of the appendices indicates in tabular form the progress of invention during the past fifty years in each of the 146 classes to which patents are allotted according to the official classification. The number of complete specifications for the year 1903 was slightly less than that for the previous year; but it was greater than for any other year, though in both 1896 and 1897 the number of applications was larger. The greatest development is shown by rotary engines, &c., (including turbines), the accepted complete specifications for which numbered 253 in 1903, as against 180 in the year before. Air and gas engines are also a satisfactory feature; the figures being 442 for 1903 and 347 for 1902. For gas distribution the patents numbered 55 in 1903 as against 54 in 1902, and for gas manufacture 144, as compared with 129. In connection with this subject, the Comptroller remarks that an analysis of the subject-matter of the applications for patents made during 1904 indicates the attention that is being given in engineering circles to turbines; more applications having been made in regard to this class of motor than for all classes of reciprocating steam-engines put together. "The keenness of the competition between gas and electricity as illuminants is," he goes on to say, "strikingly brought out by the figures of 1904; for though, on the one hand, the numbers of applications bearing upon dynamos and upon both arc and incandescent electric lamps are greater than those of 1903, there is at the same time a marked increase in the numbers relating to gas-lamps, and, what is perhaps still more significant, in the numbers relating to the manufacture and purification of gas." With this encouraging quotation we can fitly bring our notice of the report to a close.

"Field's Analysis" for 1904.—The well-known analysis of the accounts of gas undertakings which for so many years was associated with the name of Field is being continued, as our readers will no doubt remember, by Mr. George Orford, the Assistant-Accountant of the Gaslight and Coke Company, and the results of his investigation of the accounts for the year 1904 were published last week. He has dealt with those of the three London, twelve Suburban, and eight Provincial Companies, one Irish Company (the Alliance and Dublin), and eleven Provincial Corporations, including those of Edinburgh and Glasgow. The analyses present a mass of statistical information in regard to the gas supply of the Metropolis and what may be called representative towns; but perhaps the tables which occupy the last pages of the book—the comparisons of some of the principal items in the analyses with those of previous years, and the three appendices—are of the most general interest. The growth of "automatic" consumption has been remarkable. A work which has reached its 36th year of publication does not really need any recommendation.

REPORT OF THE CHIEF INSPECTOR UNDER THE ALKALI ACTS.

THE Annual Report of the Chief Inspector under the Alkali Works Regulation Acts, 1881 and 1892 (Mr. R. Forbes Carpenter), was issued last Wednesday. It is the forty-first of the series, and gives an account of the work done during the past year. As our readers are aware, the reports for the past few years have contained records of independent research in fields of investigation with which gas managers are closely concerned; and in this respect the one just issued is equal in interest to its predecessors. We deal to-day with the report of the Chief Inspector, which is made to the Local Government Board; leaving for a subsequent issue a notice of the principal features of the District Inspectors' reports and that presented to the Secretary for Scotland.

The report opens, as usual, with some statistics in regard to the works now registered under the Alkali Acts in England, Ireland, and Wales. They number 1040, compared with 1034 for 1903. Of these, 73 only are works decomposing salt, and so scheduled as alkali works; while the remainder carry on processes which are scheduled, or subject to registration, under the Acts. These numbers show a reduction of two alkali works and an increase of eight scheduled and registered works as compared with 1903. There are also 133 works registered in Scotland, bringing up the total number of works registered in the United Kingdom to 1173. The inspectors paid 5053 visits to works, and carried out 4808 tests, compared with 4838 visits and 5211 tests in 1903, and 4946 visits and 5091 tests in the preceding year. The Chief Inspector expresses his satisfaction at being able to report that no proceedings had to be taken during the year for the recovery of penalties provided in the Act of 1881 for infraction of the limit clauses regulating the amount or the intensity of acid escapes, or for failure to use the best practicable means for the prevention of the escape of noxious or offensive gases. This result, however, in two particular cases was only reached by the suspension of the severer measures pending the immediate remedying of the causes that gave rise to most serious complaint. In two cases of works found on visits by the inspectors to be carrying on scheduled processes of manufacture without having applied for registration under the Acts, back registration fees were accepted by the Board in lieu of penalties incurred.

In the portion of the report dealing with alkali waste works, reference is made to some experiments which were being conducted at the time of the issue of the fortieth report, with a view to reducing the acidity of the gases in the chimney to which was draughted the furnace dealing with the residual sulphurous gases of the Chance-Claus plant in one of the Widnes works. With the stoppage of these works, the experiments necessarily ceased. In renewing them at neighbouring works, however, various improvements in the plant were effected, to secure regularity of feed and circulation of the absorbent, and general ease of access to the towers to remove possible blockages. But it was soon found that with the greater scale of operations, and with much less opportunity for cooling, the residual gases entered the absorbing towers at a far higher temperature than before. This had a most prejudicial effect on the reactions, and produced great difficulties in working the carbonators when the circulated alkaline waste slurry reached them. The carbonated waste assumed an extraordinary gelatinous physical condition; so much so that it was necessary to revert to the use of carbonated waste itself in the absorbers in place of alkaline raw waste slurry. No blockage now occurred by its use, as in the earlier apparatus; but it was found, at the higher temperature of working, to have no effect in reducing the amount of sulphuretted hydrogen in the waste gases—its function being limited to the neutralization of the sulphurous acid portion of the gases. Some laboratory experiments were then made, the results of which are tabulated, on the efficiency of the material used. The experiments with the small Claus kiln referred to in last year's report were continued under more complete conditions for observation than in 1903; but the results so far obtained have not yet led to complete elucidation of the points on which information was sought.

Passing to the portion of the report in which Mr. Carpenter deals with works producing sulphate and muriate of ammonia and treating gas liquor, he says that these important works still continue to increase in numbers. The processes carried on in them form by far the largest contribution to the total of 1451; the sum of all the separate processes; accounting for 484, or 33·3 per cent. of the total under the purview of the Acts of 1881 and 1892. Details of the progress made will be furnished in the reports of the District Inspectors, to be noticed in a subsequent number; but in regard to the neutralization method for dealing with the foul gases evolved (first introduced in the South of England), attention is called to the necessity for care in the construction of the plant and for skilled supervision in working it. Reference is made to the fatality which occurred at the Batley Gas-Works early this year; and one of the District Inspectors (Mr. Fletcher) gives an account of the circumstances in which the bodies were found. Mr. Carpenter points out that the risks appertaining to the use of screw-down valves have been already emphasized in previous reports. It appeared, however, that the valves were tight and in good working order, and that the fatality occurred by mistake in the order of closing and opening the air-revivifying apertures in the foul gas branch-pipes, which formed a unique feature of the arrangements at these works. The same end can, he says, be with safety attained by the use of a change-valve of the hydraulic type, in the latest forms of which the gases are never unsealed. This principle was first applied at the Richmond Gas-Works in 1896. He adds that the gas liquor produced at the Batley works contains a notable proportion of ammonium cyanide. Hydrocyanic acid would undoubtedly be present in the gases inhaled; but whether this was in sufficient proportion to contribute a feature of danger additional to those already known to exist has not been established in the absence of evidence directed specially to this point. He thinks it right, however, to draw attention to the fact of its presence there and elsewhere.

Coming to the portion of the report which has special interest for gas managers—that in which Mr. Carpenter deals with the recovery and production of ammonia—we find the usual table in which, through the courtesy of manufacturers, he is able to present the figures showing the produce of ammonia from all sources in the United Kingdom. They are as follows:—

—	1904.	1903.	1902.
Gas-works	150,208	149,489	150,055
Iron-works	19,568	19,119	18,801
Shale-works	42,486	37,353	36,931
Coke-oven works	20,848	17,438	15,352
Producer gas and carbonizing works (bone and coal)	12,880	10,265	8,177
Total	245,990	233,664	229,316

Commenting upon these figures, Mr. Carpenter points out that the most important contributor is still the coal gas industry; but the figure has remained practically stationary during the past three years. In the manufacturing districts of the Midlands, Lancashire, and Yorkshire, the stagnation of trade in many industries was, he says, the cause of lessened demand for gas in factories, counterbalancing the natural tendency to increase in domestic uses that would otherwise have made itself felt in the total gas output. While the last-issued statutory returns again show an increased production of carburetted water gas, in many large works the condition of the oil market was not considered favourable to the operation of plant for its manufacture. Any increase in the output of gas should, in such works, have been accompanied by an extra make of sulphate of ammonia. In every other subhead in the table it is pleasant to note an increase. The two industries in which ammonia is recovered that follow next after gas-works—iron-works and shale-works—are nearly entirely confined to Scotland—the latter exclusively so. The most notable development in England and Wales is certainly the extension of the application of ammonia recovery to coke-oven plants; and Mr. Carpenter says it appears likely that in the current year the rate of extension will be even greater than it was during 1904. With regard to the last subhead in the table, there has not been any increase in the recovery of ammonia in the bone and coal carbonizing works; the advance recorded being entirely due to the starting of several large producer-gas plants. Scotland has had a large share in this increase.

A portion of the report is again devoted to the subject of the testing of ammoniacal liquor, and the results of two analyses are given, in continuation of those which have appeared in previous reports. The first has a melancholy interest from the fact that it is a record of an analysis of liquor from the Batley Gas-Works, where, it may be remembered, two lives were lost in consequence of exposure to the foul gases on their passage to the oxide of iron purifiers. Not only is the proportion of sulphuretted hydrogen in these gases decidedly large, but the gases are associated with hydrocyanic acid in greater quantity than that found in any sample of gas liquor examined, with the exception of that from the Old Kent Road works of the South Metropolitan Gas Company referred to in the report for 1903. The second sample came from works where a cyanide-extraction process is in operation on the crude gases before the ammonia extraction plant. In this case the proportion of ammonia as sulphate was high; and there was a certain amount of cyanogen compounds not recovered as ferrocyanide, and passing on to the ammonia scrubbers and washers, as shown by the presence of sulphur and ammonia as sulphocyanide.

We learn from the report that more interest appears to have been taken in the recovery of cyanogen compounds from crude coal gas during the past two years. While ferrocyanide is the form aimed at in most recovery processes (sulphocyanide being regarded as so much loss, the formation of which has to be specially guarded against) one process, to which extended trial on a large scale has been given, chooses this form of combination as the one offering the best advantages for ultimate conversion into the desired sodium cyanide. Mr. Carpenter considers that the reactions utilized in this process may be capable of being linked with others designed to effect the removal of sulphur compounds from coal gas. In a previous report he traced up to 1900 the history of the use of ammonia in gaseous or liquid form for the removal of the impurities in coal gas. In two large works these reactions are still applied as adjuncts to the usual system of purification by lime or oxide of iron. On this subject Mr. Carpenter makes these remarks:

Up to the present it may certainly be said the conditions for ensuring

reduction of the sulphur compounds by bringing the gas into intimate contact with ammonium polysulphide are not known with such exactness that it can be laid down that a given plant, operated in a given way, will day by day reduce these sulphur compounds below desired fixed limits in a crude or partially purified gas where they occur in the usual known quantities. . . . Where gas managers are subject to statutory limits as regards these compounds, and feel as acutely as they do the responsibilities placed upon them in this respect, it would seem natural to anticipate that a systematic experimental study of the reactions mentioned above might be undertaken with the hope of ultimately replacing the foul-lime purification method, open as this is to the objections put in detail before the recent Departmental Committee on Gas-Testing in the Metropolis.

Mr. Carpenter thinks it is hardly to be hoped that, without calling into aid the employment of ammonium polysulphide as an active reagent, the ordinary desulphurized gas liquor of the Hills or the Holgate process, however applied, will succeed in securing permanent reduction in the sulphur compounds, efficient as it is as an agent in removing a large percentage of the impurities of carbonic acid and sulphuretted hydrogen. He says it is only by further exact study over a prolonged period, with very varied conditions, both in winter and summer, that the data necessary for ensuring the success of the process at all times can be ascertained. The technical results then have to be regarded in their commercial aspects.

Returning to the consideration of questions more directly arising from the study of analytical methods for ascertaining the constituents of ammoniacal liquors, attention is called to some further experiments carried out by Mr. Carpenter's assistant (Mr. S. E. Linder, B.Sc.), and described in detail in a memorandum by him. These investigations are very highly spoken of by the Chief Inspector, who expresses his appreciation of the skill and zeal bestowed upon the work. An opportunity may present itself of noticing them at greater length in a future issue.

The only other matter in the report calling for remark now is the paragraph on tar-works. Mr. Carpenter says works of this class are by far the most widely spread throughout the country of the processes of which the supervision was added to the inspecting staff by the Act of 1892; the number of works where tar distillation or heating in any manufacturing process is carried on having increased to 134 in the year under review. No special features in the administration of the Acts presented themselves for detailed comment during the year. The Chief Inspector states that the nuisance arising from the varied operations carried on in these works has certainly been reduced by the operation of the Acts. The standard of efficiency, however, still varies widely. "Where the management is alert and keen, and there is intolerance of untidiness and slovenliness, the atmosphere of the works is much sweeter, notwithstanding the magnitude of the operations, than in many works of much smaller size where the ground, sodden after years of drips from leaky apparatus, contributes its quota to the odours pervading not only the works themselves, but also the immediate neighbourhood. It is difficult to persuade such proprietors that leaks spell loss."

The Evidence before the Coal Commission.

We have received from the Chichester Press, Furnival Street, E.C., the first volume of the "Digest of the Evidence given before the Royal Commission on Coal Supplies, 1901-5," reprinted from the "Colliery Guardian" after revision by the witnesses. The volume deals with the working of thin seams, the limit of depth in mining, waste in working, and coal-cutting by machinery; and it will be followed by two others. The digest is preceded by an introduction recounting the early history of the coal question, and containing other interesting matter, including the final report of the Commissioners. The evidence is freely illustrated by diagrams, mainly reproduced, by permission of the Controller of the Stationery Office, from the report; but some have been specially re-drawn by the witnesses. There are six appendices, which are followed by a valuable bibliography of important works dealing with the subjects treated in the volume, and an equally valuable index. There is a frontispiece consisting of a group of portraits of the members of the Commission, the centre being occupied by the Right Hon. Lord Allerton, LL.D., F.R.S., the Chairman, who has accepted the dedication of the work to himself. The volume is in quarto size and clearly printed; and when its companions are issued, the public will be in possession of a permanent record, in a convenient form, of the proceedings on one of the most important inquiries ever conducted by a Royal Commission.

Locomotives and Railway Waggons in Gas-Works.—Our attention has been called to proposed regulations under the Factory and Workshop Act of 1901 for "the use of locomotives, waggons, and other rolling stock on lines of rails or sidings in any factory or workshop." These will, if carried out, render it impossible to work many narrow lines of rail for removing coke, lime, &c., in gas-works; and as notice of objection has to be given before the 21st inst., there is no time to be lost in taking the necessary steps. The notice required to be given in the first instance is, we believe, purely formal; and the specific objections can be put into more detailed form later, when possibly a hearing will be granted. Gas companies and local authorities should immediately communicate with Mr. Taylor, the Secretary to the London Waterside Manufacturers' Association, at Messrs. Tate and Sons, 21, Mincing Lane, E.C.

PERSONAL.

It will be seen by the list of successful candidates at the last examinations in "Gas Manufacture" which appears elsewhere that Mr. ARTHUR GORDON KING has passed first class in the Honours Grade. He also gained third place in the Honours Grade at the recent gas examination at the Regent Street Polytechnic. Mr. King is the son of Mr. Arthur King, the General Manager of the Gravesend Water Company, and is a pupil of Mr. Joseph Davis, the General Manager and Engineer of the Gravesend and Milton Gas Company.

It will be seen by a paragraph which appears in another part of the "JOURNAL" that Mr. HARRISON VEEVERS relinquishes the position of Engineer, Manager, and Secretary of the Gas Department of the Dukinfield Corporation, and becomes the Consulting Engineer to the Gas Committee. The change has been made in connection with a scheme for the re-organization of the department which was sanctioned by the Town Council at their last monthly meeting, and it severs a connection with active work in the supply of gas at Dukinfield which has subsisted for a quarter of a century. It was about the year 1880 that Mr. Veevers removed from Bolton, where he had been for some time, to Dukinfield; and to most of his professional colleagues his name will always be associated with the Cheshire town. When he entered upon his duties, the undertaking was the joint property of the Local Authorities of Dukinfield, Denton, and Haughton; but the partnership was dissolved in 1885, after arbitration proceedings to determine the amount of compensation to be paid to Denton. It was while he was at Bolton, in 1865, that he joined the British Association of Gas Managers; and he remained with that body throughout its several changes. He is a member of the Manchester District Institution of Gas Engineers, and for a short time held the position of Honorary Secretary; but in 1889 he relinquished it, and was succeeded by Mr. S. S. Mellor.

OBITUARY.

At the last meeting of the Board of the Farnworth and Kearsley Gas Company, a vote of condolence was passed with the family of the late Mr. J. W. WATKINSON, who had been a Director of the Company since 1883, and for the past seven years had filled the position of Chairman.

A familiar figure at gatherings of Scottish gas managers during the past thirty years has been removed by the death on the 3rd inst., at his residence in Glasgow, of Mr. JOHN MAYER. The deceased started in life as a teacher, and in the early sixties he filled the post of Head Master of the Secular Grammar School in Carlton Place, Glasgow. He subsequently turned his attention to journalism, and for some years he was our Glasgow Correspondent, as well as a contributor of local news to other papers. He took much interest in scientific matters, on which he from time to time lectured. He was a Fellow of the Chemical Society and filled the position of Secretary of the Glasgow Philosophical Society. Mr. Mayer was 75 years of age.

A GAS MANAGER ON RATING.

OUR readers are aware that in connection with the Manchester District Institution of Gas Engineers there have been formed Commercial Sections, which have been productive of much good to the members. The reports of the meetings of these sections come before the general body, and are entered upon the minutes; but, being of a semi-private character, they are not included in the published proceedings of the Institution. At a meeting of the Lancashire Section held towards the close of last year in Manchester, Mr. F. A. Pye, the Secretary and General Manager of the Chester United Gas Company, made some interesting observations on the subject of rating; and as they constituted, to all intents and purposes, a paper on this matter, the Committee of the Institution have sanctioned their publication. We have recently received from the author a print of his remarks.

NOTES ON RATING.

A *résumé* of the ancient methods of assisting the poor by the taxation of residents and property in a parish, however interesting—dating back as it does, in some form or other, to King Alfred's reign—would take up more time than can advantageously be spared on this occasion. Alterations in the *personnel* of the body making the rate, in the methods of publishing and enforcing it, and in the mode of appeal have been numerous; but the Poor Relief Act, 1601—the second statute passed in the 43rd year of Queen Elizabeth—providing for the relief of the poor, is still the foundation on which the present law of rating is based. The various statutes amending the procedure of publication of the rate, and appeals against and methods of enforcing same, are beyond the scope of the object of these notes, which is the consideration of the method of assessing gas-works for poor-rate under the law as it now exists.

All are probably aware that (with, I believe, few exceptions

under some Local Acts of Parliament) the assessment made for purposes of poor-rate is applicable for all rates collected by the Overseers and their assistants. The Parochial Assessments Act, 1836, provides that "no rate . . . shall be allowed by Justices which shall not be made upon an estimate of the *net annual value* of the several hereditaments rated thereunto—*i.e.*, the rent at which the same might reasonably be expected to let from year to year free of all usual tenant's rates and taxes and tithe commutation rent-charge, if any, and deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses, if any, necessary to maintain them in a state to command such rent." The Poor Rate Exemption Act, 1840, exempts inhabitants of parishes, &c., from liability to be rated as such in respect of profits to be derived from stock-in-trade or other property—*i.e.*, profits of trade.

The Union Assessment Committee Act, 1862, provides that the gross estimated rental shall be "the rent at which the hereditament might reasonably be expected to let from year to year free of all usual tenant's rates and taxes and tithe commutation rent-charge, if any." Comparing this Act with the Parochial Assessments Act, 1836, the difference between the gross estimated rental and the net annual value is seen to be the deduction from the former of the "probable average annual cost of the repairs, insurance, and other expenses, if any, necessary to maintain them in a state to command such rent."

These statutes are the primary bases of assessment; and in the principle of net annual value—*i.e.*, "rent . . from year to year"—perhaps the rule laid down that all rating must be equal should be carried out as far as practicable in ordinary cases. The whole difficulty and cause of disagreement lay in ascertaining that figure, in cases of gas-works, owing to the fact of the tenant being invariably also the landlord. Profits, as pointed out, are not rateable; and in making an assessment, it has to be ascertained what a tenant would be likely to give as rent for the purpose or privilege of working the undertaking and supplying gas from the gas-works as existing. Numerous decisions have, however, been given, confirming the principle that in arriving at the rent the profits must be considered. Difficulties arise in ascertaining the value of the landlord's as distinct from the tenant's property therein, also in apportioning the expenses of working between them.

In practice, the method of making an assessment appears to be as follows: The gross receipts of the year's accounts are taken, including all meter and stove rents, residuals, and miscellaneous receipts. From these are deducted all the ordinary items of working expenses as enumerated in the schedule form of revenue account, with the exception of rates and taxes and sinking and other funds of a like character; leaving a balance which may be called normal receipts. All available information affecting the amount which the undertaking might reasonably be expected to let at must be given; and therefore, although some one or more years' accounts must be considered as the basis of valuation, the figure so arrived at should be corrected, by addition or diminution as the case may be, for any ascertained differences owing to the year not being a normal one. Such alterations will be for rise or fall in the price of gas, coal, or labour, ascertained subsequently to the making up of the account on which the assessment is based. Repair and maintenance must, if necessary, be corrected to an average figure reasonable for an undertaking of similar size. Law and parliamentary and other charges liable to considerable variation should be averaged. From the corrected balance left must be deducted a sum for tenant's profit and tenant's rates and taxes. These rates and taxes are to be calculated on the net annual value ascertained. The balance is the gross estimated rental, from which, in order to arrive at the net annual value upon which sum the rates will be made, must be deductedthe cost of repairs, insurance, and the other expenses necessary to maintain the undertaking in a state to command the rent. The tenant's profit is calculated at 17½ per cent. on the amount of his capital employed—viz., 5 per cent. interest, 10 per cent. trade profit, and 2½ per cent. risks and casualties—at least it is at this rate that the allowance has most frequently been made in reported cases, and it is the common practice at the London Quarter Sessions.

The sinking fund to provide for maintaining the works in a state to command the rent is, I believe, generally, as argued by Mr. Newbigging in his book on the subject,* based on a 30 years' life all round on a 3 per cent. interest table; and this, calculated on the structural value of the works and mains, is the landlord's deduction for renewals. Insurance is calculated at about ¼ per cent. on a reasonable part of the works' structural value, and also deducted. In places where the gas supply is confined to one parish, in which also the works are situated, the assessment is completed; but where, as is usually the case, more than one parish is supplied, the assessment has to be apportioned. This is done by allowing a reasonable rate—about 4 per cent. would be probably so considered—on the structural value of the works and connecting mains thereon, and allowing this sum as the assessment at the works. But I gather from Mr. Newbigging's arguments that it is not usual to allow a higher rate on the structural value of the works than the whole assessment bears to the total structural value of the works *plus* the whole of the mains in all parishes.

* "The Valuation of Gas, Electricity, and Water Works for Assessment."

After thus ascertaining the rateable value of the works, the balance of the assessment is the rateable value of the mains, and is apportioned to the various parishes supplied in the proportion that the receipts for gas in those individual parishes bear to the total gas-rental. This method will, of course, require adaptation to local circumstances. Works in various parishes will require valuation separately, but still on the basis of structural value. Feeder mains laid through one parish for the supply of an outlying parish are assessable on the structural value in the parish through which they pass without being tapped for the purpose of the supply in that parish. Governor stations would also be assessed, on a similar basis, to the parish in which they are situated. All such assessments based on structural value are deducted from the ascertained total assessment before ascertaining the balance forming the assessable value of the mains to be apportioned to the various parishes.

In the case of works of much larger capacity than the requirements for the time being, an allowance would be made in apportioning the assessment between the works, and the mains, so as not to unduly decrease the assessment to parishes in which mains only lie. This allowance would be either by decreasing the structural value of the works, or the rate of interest allowed on the actual structural value. But such an allowance would not affect the total assessment of the undertaking, which has been arrived at from its profit-bearing capacity.

I must now revert to the tenant's capital; it being one of the most difficult questions, and the most contested. It consists of—

1.—Working capital, which used to be calculated on 4½ to 5 months' working expenses, less a small amount received for residuals, supposed to be paid for more promptly than gas. With the advent of prepayment meters, I think an allowance will in future have to be made in respect of the earlier collection of this source of revenue. A claim has also been made for the first quarter's rent to be added to the working capital; but it is questionable if this can be supported, when the above allowance is secured.

2.—Costs of stoves, meters, fittings, and other apparatus on consumers' premises.

3.—Trade fixtures, being all the moveable tools and apparatus required on the works and for main and fitting works—everything which a tenant could remove without prejudice to the gas-works as such; and it would, I think, include locomotives and such coke and coal handling plants as are not attached to the ground.

Although decisions have been given that these stores (Nos. 2 and 3) must be valued at the present actual value, I think that the cost price is the correct value; and the argument should be advanced that the tenant has at one time or another to pay that cost price for them, and that when the time comes for renewal he will have to replace them without any further addition being made to his capital account.

4.—Stores of coals, purifying materials, &c. The store of coals, &c., must not be taken at what may happen to be the exact stock at the time of valuation, but must be sufficient to secure an adequate supply in midwinter or any other period when the demand for gas is heaviest. I contend that this should be at least six weeks of the heaviest daily requirements.

The allowance of 17½ per cent. on the total of the tenant's capital is often contested by professional valuers; but, as already pointed out, it is allowed in the London Quarter Sessions. Considering that this allowance is practically the only deduction from the profits of the undertaking, and consequently the only inducement any tenant can have in renting the concern, it is little enough; and, taking into account the serious loss of monopoly sustained by gas undertakings with the advent of various competitors, it is very necessary to jealously guard against any diminution in the rates allowed on tenant's capital, as well as to see that a full adequate sum is allowed as capital.

There is little difference between a gas undertaking in the hands of a company or of a local authority. Should a local authority supply gas without profit at all, they are still assessable, as it has been frequently decided that in case of an occupation which is usually profitable being maintained, owing to diminution in charges, without securing profit, such an occupation is assessable at the amount which is saved owing to the charges being so reduced that no profit is made. Public lighting, if done free, would therefore be liable, on these grounds, to be valued for assessment. In considering the structural value of undertakings owned by local authorities, no notice would be taken of sinking fund accumulations.

In conclusion, I must say that I think this question is one of many in which a Gas Companies' Association would be invaluable. To my mind, injustice is undoubtedly done in assessing gas undertakings on so large a proportion of the total profit obtainable; but the cost of appeal is so heavy that in many cases it is less expensive to accept an assessment very largely in excess of what would most probably be maintained as correct, if the case were taken to the Sessions. Were such an Association in existence, with all precedents at hand, it would not only considerably reduce the cost of appeal, but materially assist in securing uniformity of practice on more equitable principles. The theory of rating is equality; but, under present procedure, I fail to see how it is secured in concerns like railways and gas and water works.

INSTITUTION OF GAS ENGINEERS.

EXPERIMENTS WITH LOW-GRADE MIXED GASES.

By J. H. BROWN, of Nottingham.

[A Paper submitted to the Annual Meeting, June 1.]

In presenting to the Institution the results of careful experiments extending over a period approaching three years in connection with the use of blue water gas in conjunction with the carbonization of gas coals and cannels, the author feels that no excuse or apology is needed. The question is one of universal interest, and has been made the subject of many spirited debates and much acrimonious newspaper correspondence between gas engineers; and it has, unfortunately, quite recently been made a party question in the council chamber of one of our fairly large corporations.

The writer does not forget that the results of many similar experiments have been presented to the gas profession, and cannot, of course, ignore the very able paper by Professor Lewes on experiments carried out at the Sydenham Gas-Works, the papers by Mr. Stephenson, of Tipton, and Mr. Brockway, of Cleethorpes, the paper by Herr H. Dicke, and also the figures presented by the Imperial Continental Gas Association on the results of self-carburetting at the Mariendorf Gas-Works. His contention, however, is that in no case have the experiments been made under such favourable conditions as those which exist at Nottingham, nor have the results been presented in so complete and extensive a form as to include the whole of the information and data which could possibly be asked for by the most exacting critic.

Hitherto very little progress has been made in the use of blue water gas in English gas-works; and, owing to questions of policy, and from other causes perhaps, its *raison d'être* has not been generally considered by British gas engineers. From the particulars he is about to submit, the writer thinks he will be able to prove that the position of blue water gas must be reckoned with in the future, if only on account of its use in diluting gases obtained in the carbonization of rich coals and cannels. He believes there is a great future for blue water gas, and that its possibilities will probably greatly extend in proportion to the increase of knowledge of the principles underlying the various processes of carbonization.

In 1901, when Engineer at Ilford, the writer was fortunate in being present at the reading of a paper by Professor V. B. Lewes, at the Engineering Congress in Glasgow, on his experiments with blue water gas at the Sydenham Gas-Works. Shortly afterwards, the Directors of the Ilford Gas Company, owing to the unprecedented growth of their undertaking, were compelled to consider the immediate extension of their works. They had arrived at a time when it was necessary to entirely remodel the plant, and were about to commence the erection of a complete new gas-works, which would have involved a very considerable outlay. After carefully considering several possible schemes, it was decided to erect a blue water-gas plant, in order to tide the undertaking over the following two winters; for it was found that the expense of doing this would probably be less than two years' interest on the capital necessary for the building of a new gas-works, as originally intended. Even assuming that the water-gas plant was only to be used as a temporary aid for the two following winters (apart from any saving in the cost of manufacturing the gas), its erection appeared to be the most economical course to adopt.

The plant was put down largely as an experiment, and was regarded by the Directors in the nature of a speculation. It is, therefore, gratifying to be able to say that, after several years' experience with the plant, they are exceedingly pleased that they decided to adopt it. From the time it was started careful records and full details of the working results were taken, and every possible precaution adopted so as to ensure that the figures and records were absolutely reliable. It was found impossible, however, to attain the very favourable results that were published at the Glasgow Congress, and which finally were looked upon as somewhat idealistic. Although every possible effort was made, the author was unable to collect any particulars or figures in such a form that they could be presented with confidence as an example of the improvements in the carbonizing results which might be expected on any other gas-works by the adoption of blue water gas. He commenced at Ilford by adding 5 per cent. of water gas in the hydraulic main, no appreciable decrease in illuminating power being noticed; and on one occasion, with the addition of 15 per cent. of blue water gas, he obtained the surprising increase in the illuminating power of nearly half-a-candle.

For a considerable period experiments were continued at Ilford with this process, without obtaining any regular continuous results such as could be repeated at will. Experiments were also made with American gas oil; gasifying it in ordinary coal-gas retorts, through which at times a stream of water gas was passed. This process gave great satisfaction for several months, and was abandoned mainly on account of the increase in the cost of gas oil. It has since been adopted in a more extended form on other works.

Considerable time and trouble were expended in connection with these experiments and records at Ilford, with the idea of publishing them at some future period; but finally they had to be abandoned, owing to the writer's removal to Nottingham. He determined, however, that the matter should not be allowed to rest, and that immediately any favourable opportunity presented itself, he would obtain a complete and reliable record of the results of mixing blue water gas with the coal gas during carbonization. The work of previous experimenters seemed to him to have left much to be desired, either in the plant or the methods employed in making the tests; and although the author may be freely criticized as to some of his methods, he has benefited from the experience of other workers and avoided some of the probable sources of error to which they were liable in making their experiments.

In the Sydenham tests, the measurement of the water gas did not appear to be satisfactory; and the same must be said of the Mariendorf results. Herr Dicke states in the early part of his paper that although he experimented with a plant complete in every respect, and had every possible assistance at Frankfort, together with the help of "Herr Spitzer and Dr. Messerschmitt, who displayed untiring zeal for many months, and notwithstanding that very valuable material was collected on the details of the method of self-carburetting during these tests, yet it was found that the working fluctuated so very much, despite the good and complete gas equipment and the exactness of the observations made, that it was impossible to publish precise figures with respect to it."

From previous personal experience with self-carburetting processes, the writer was fully aware of the many difficulties and probable sources of error, which might account to some extent for the fluctuating results mentioned above. Yet he determined that all these difficulties should be overcome, and that he would present records of tests which could be repeated at will, believing that any results which would satisfy this severe requirement would be readily accepted as reliable and trustworthy.

Testing Apparatus.

On arrival at Nottingham, the author found that there existed a very complete coal-testing plant, capable of carbonizing 10 or 12 tons of coal per day; and immediately adjoining this small complete gas-works was a "Furness" oil-gas plant. He commenced at once to reconstruct the oil-gas plant and to get the coal-testing plant into working order for making these experiments. For a short period experiments were made with a "methane-hydrogen" water-gas plant, with varying results. Finally it was decided to reconstruct what remained of the two plants and to generate sufficient blue water gas in a small experimental water gas plant, which was constructed for the purpose from what remained of the "methane-hydrogen" and the "Furness" plants.

The coal-testing plant is connected with a very complete laboratory adjoining the No. 1 retort-house at the Basford works, which house was erected some time prior to 1840, and contains twelve beds of through retorts in sevens, of 15 in. by 21 in. section by 18 feet long. The hydraulic and foul mains are so arranged that although, under the normal working conditions, the whole of the gas is drawn to the exhausters dealing with the gas from the larger retort-houses on this works, one, two, or three beds can be completely isolated, and the tar and gases therefrom can be drawn towards the testing plant by its own exhauster. This testing

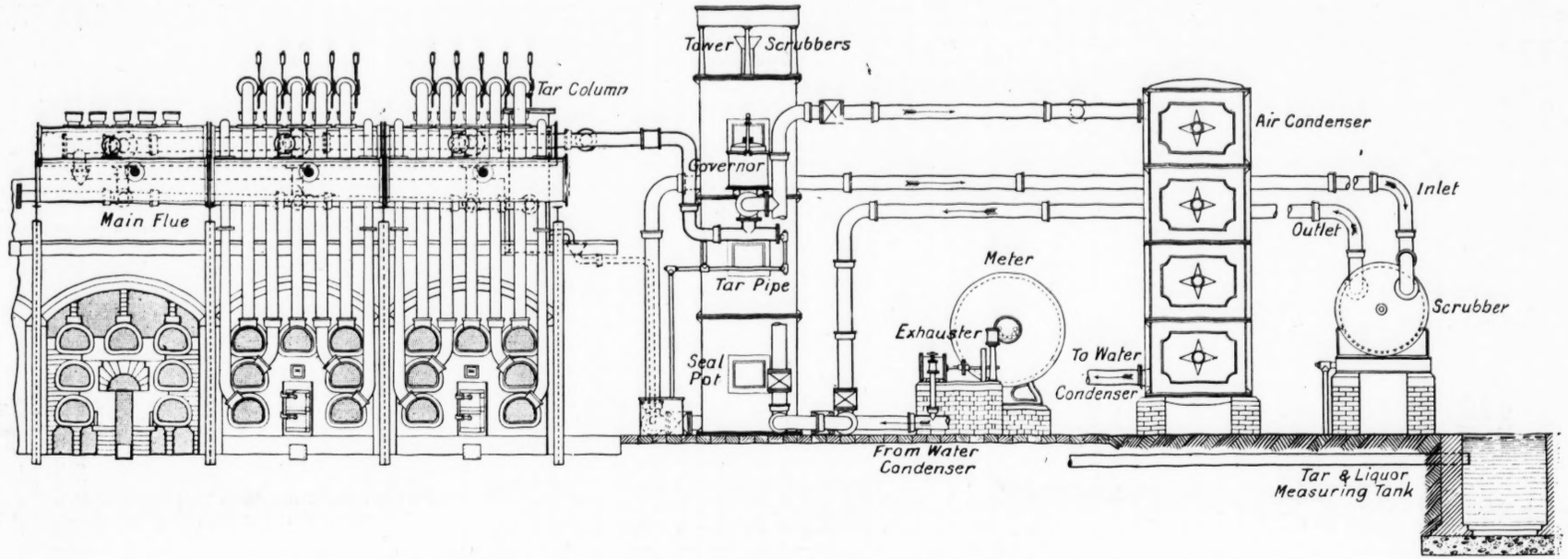


FIG. 1.—SIDE ELEVATION OF THE EXPERIMENTAL PLANT AT THE BASFORD (NOTTINGHAM) GAS-WORKS.

plant was erected by Mr. Lewis T. Wright, and is a model of completeness.

The gas and tar are conducted from the retort-house into the testing plant. The tar being taken off by a tar-syphon, the gas goes forward through an atmospheric tubular condenser, 5 feet square by 16 feet high, containing 100 air-tubes 3 inches in diameter. The gas is then drawn through a finishing condenser, 12 ft. long, 5 ft. 6 in. high, and about 2 ft. wide, containing coils of 6-inch pipes immersed in water. This water condenser enables the temperature of the gases to be controlled to any desired temperature.

The gas then passes through a small exhauster (5000 feet per hour) worked by a vertical steam-engine, and accurately governed on the steam supply by the ordinary type of gas-governor. A governing bye-pass is also fitted between the inlet and outlet of the exhauster, and the gas travels to the two tower-scrubbers, 19 feet high by 5 feet diameter, filled with boards. Through these, a constant stream of weak liquor is regularly pumped. The gas then travels from the scrubbers to a rotary washer-scrubber, 4 ft. 6 in. diameter by 10 ft. long, containing eight divisions; thence through the purifiers, which are 10 feet square by 4 feet deep, each containing four 10-inch layers of lime; and afterwards through a station meter of 10,000 cubic feet per hour capacity, to either of the two experimental gasholders, each of a capacity of about 150,000 cubic feet.

Thermometers are fixed on each portion of the apparatus; and every facility exists for drawing from any portion of the plant samples of gas for analysis. In the adjoining laboratory there are three experimental test-holders, into which is drawn, at a constant rate throughout the twenty-four hours, a sample of the gas as it is being made. After allowing the sample to rest for several hours, it is tested for its illuminating power, specific gravity, and calorific value. Finally, it undergoes a complete gas analysis.

On mentioning the desirability of carrying out experiments with this process, the Gas Committee of the Nottingham Corporation very readily consented, and gave permission to rent a house adjoining the works for the use of the three chemists who were to assist, and but for whose painstaking and untiring efforts in the solution of the very many and perplexing difficulties which cropped up from time to time, it would have been almost impossible to have brought the experiments to a successful issue.

It appeared to the author that the best course to adopt was to carbonize, in conjunction with the self-enrichment process, various representative gas coals and cannels; and although for many years past it had been the practice of the Gas Department to make repeated tests of all coals purchased, and there existed innumerable records of such tests of every well-known gas coal in the Yorkshire, Derbyshire, and Nottinghamshire coalfields, he decided to begin anew, and to establish fresh figures with which to compare the results obtained with the use of blue water gas. It was therefore necessary to carbonize the coals throughout each series of tests as nearly as was possible under the same conditions.

The coal was carbonized in one of the twelve beds in No. 1 retort-house, which was in about average condition; and although the retorts are heated by old-fashioned direct fires, yet the ordinary carbonizing results obtained have always been regarded as satisfactory. Charges of 4½ cwt. of 5 hours' duration, were used throughout the tests. Each charge was carefully weighed, and the weighings checked off against the total coal coming into the house.

The figures given in the various tables appended embrace practically every item which could possibly be desired in forming an opinion of the value of the process. *The condition of the retorts from day to day is there carefully noted;*

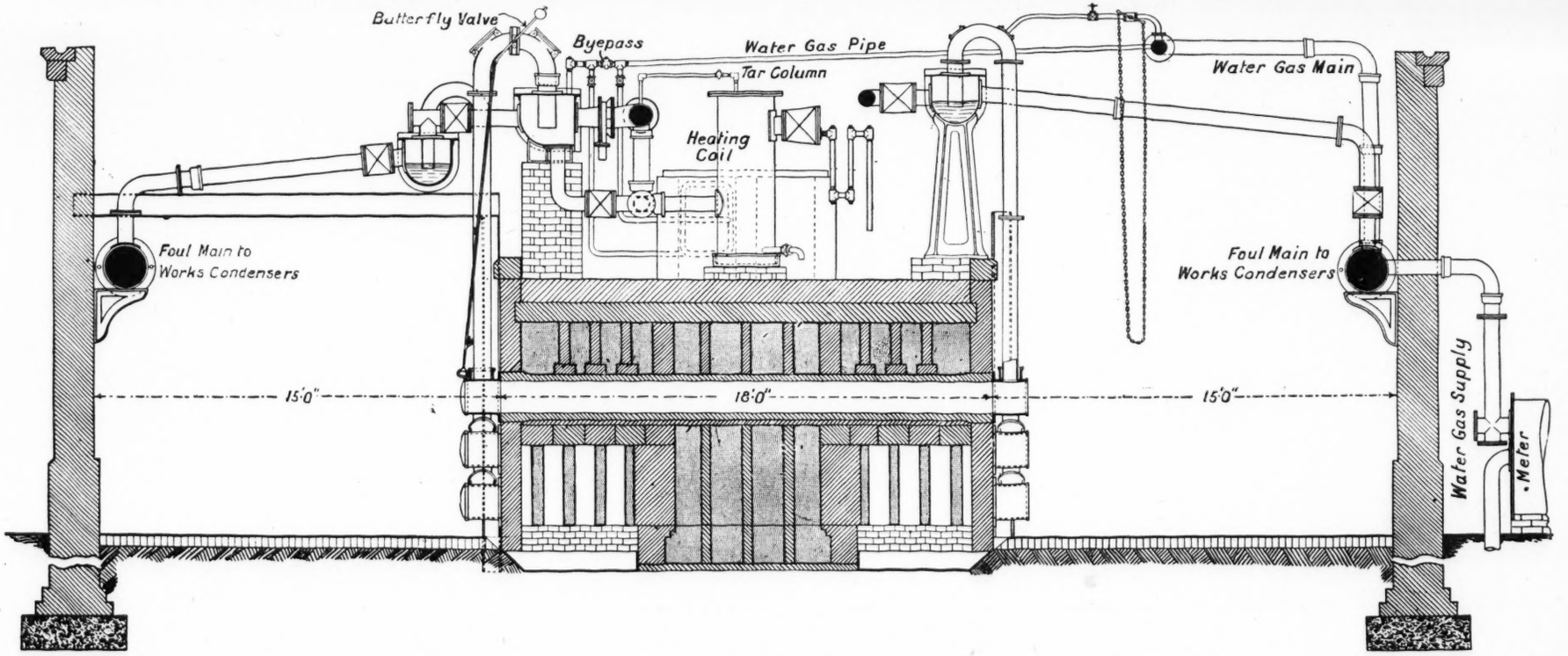


FIG. 2.—TRANSVERSE SECTION OF THE EXPERIMENTAL PLANT AT THE BASFORD (NOTTINGHAM) GAS-WORKS.

and a diagram showing the daily record of pressure in the hydraulic main is also submitted. For the greater portion of the time a second diagram was taken from the retorts themselves. The quantities of gas registered have in every case been carefully corrected for normal temperature and barometric pressure. The illuminating power was determined by a 60-inch Letheby bar photometer, using a No. 1 standard "London" argand; the gas burning at such a rate as to give its maximum lighting value. The calorific power was obtained by means of a Junkers calorimeter.

The crude gas per ton is shown day by day so as to estimate the pounds of cyanogen per ton of coal; the cyanogen test being taken from a sample of the gas drawn from the exhauster outlet. The crude gas at this point was also analyzed for oxygen, carbon dioxide, sulphuretted hydrogen, and ammonia, as shown in the tables.

The water gas for these experiments was made in the experimental plant, and contained usually between 2 and 4 per cent. of carbon dioxide and sulphuretted hydrogen. Sufficient water gas for several days' tests was passed into one of the experimental gasholders, and no more was added until the whole quantity had been used, when the holder was again filled up. Before leaving the water-gas plant and passing into the holder, this water gas was reduced to atmospheric temperature by means of a scrubber and condenser; and it was almost invariably found that, on arrival at the water-gas meter, the difference between the temperature of the gas and that of the atmosphere was never more than one or two degrees. By allowing the gas to stand for several days, any excessive percentage of water vapour was entirely avoided; and the regularity of the daily tests of the crude water gas shows conclusively that the sample remained constant throughout the period of using each holderful.

In the daily tables, the "Percentage of Water Gas Added" is calculated on the crude unpurified water gas corrected for N.T.P. as it leaves its own meter; but the "Percentage of Water Gas in the Bulk" is calculated on the purified water gas—that is, less the carbon dioxide and sulphuretted hydrogen, impurities which are taken out by the lime in the purifiers. In calculating the "Make of Coal Gas alone per Ton," it is necessary to deduct the percentage of carbonic acid contained in the crude water gas.

In the analysis of the purified coal gas, it was at first attempted to estimate the paraffin hydrocarbons separately. But this idea was abandoned, and it was decided to absorb all the hydrocarbons with very strong bromine, and to estimate them as so many cubic feet of hydrocarbons per ton of

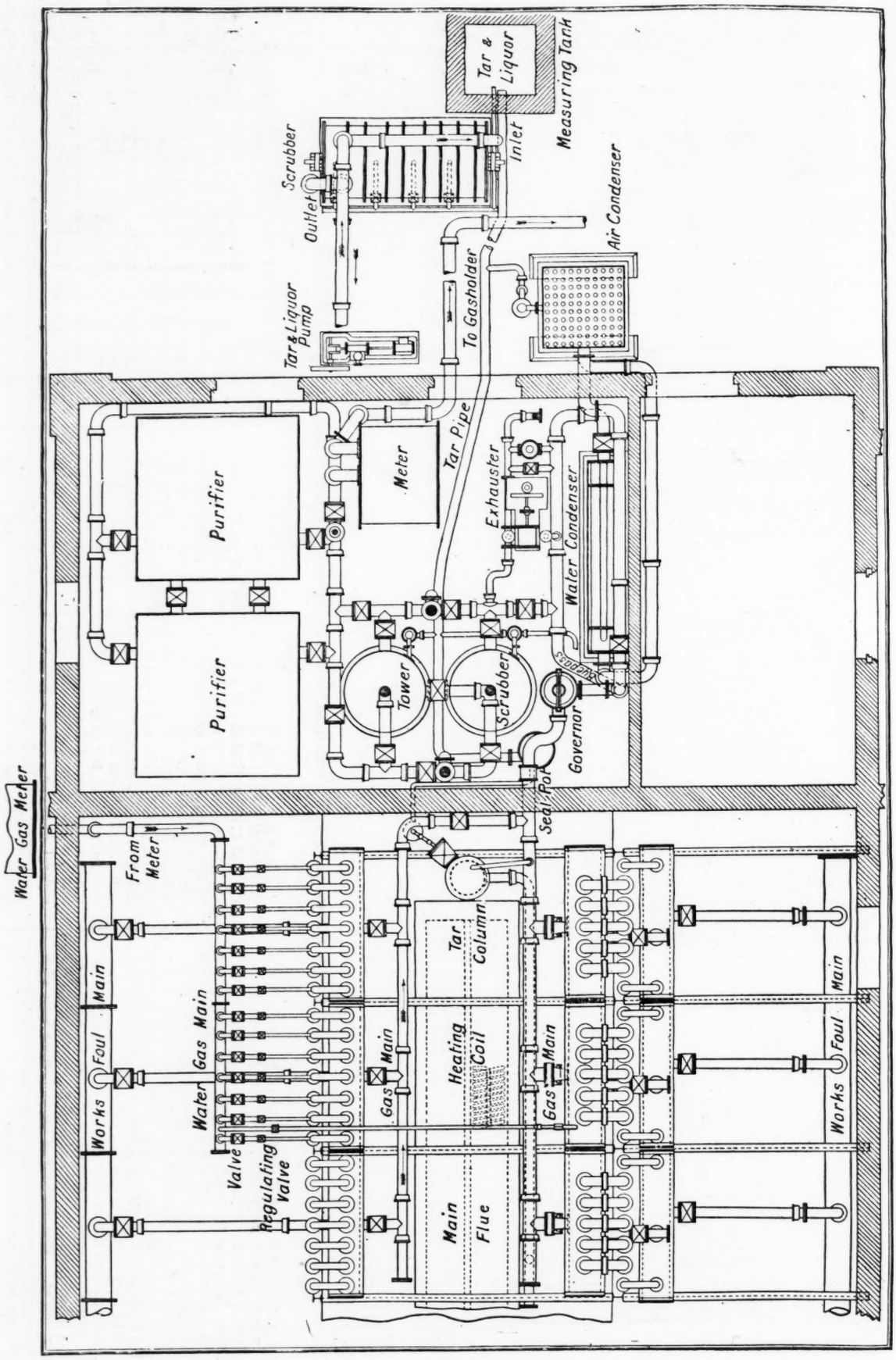


FIG. 3.—PLAN OF THE EXPERIMENTAL PLANT AT THE BASFORD (NOTTINGHAM) GAS-WORKS.

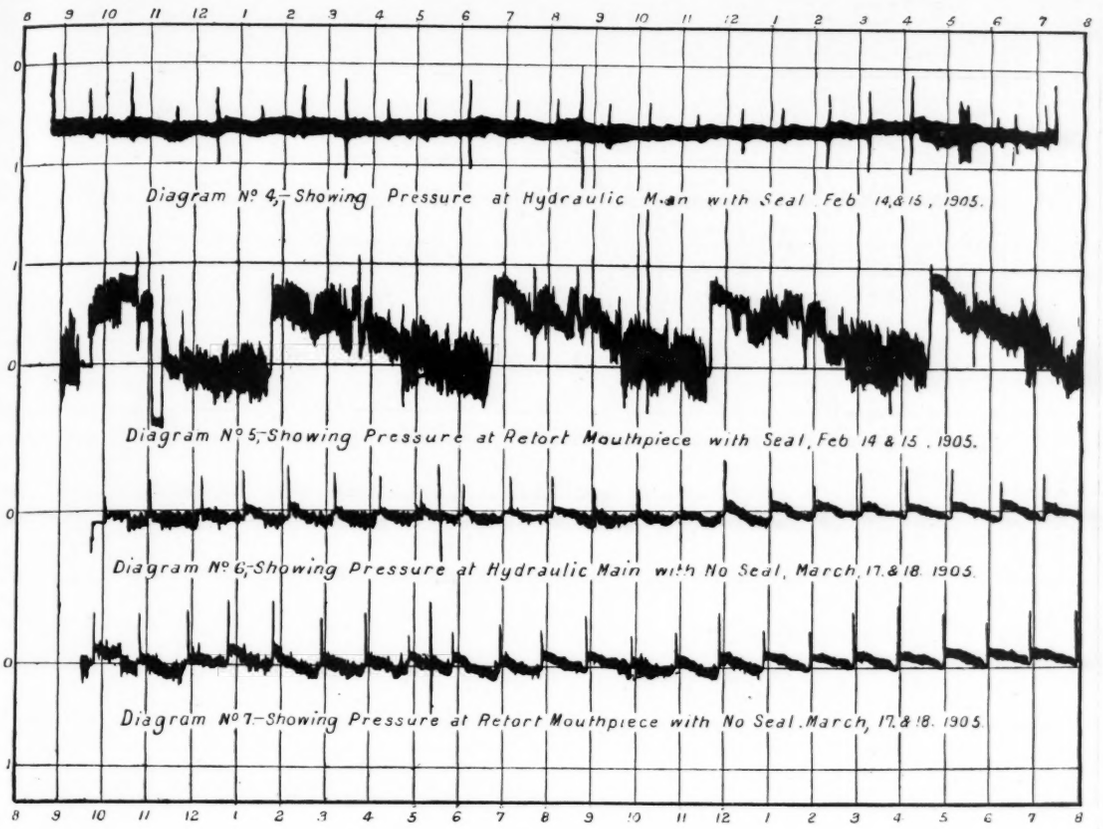


Diagram No 4,—Showing Pressure at Hydraulic Main with Seal Feb 14,& 15, 1905.
Diagram No 5,—Showing Pressure at Retort Mouthpiece with Seal, Feb 14 & 15, 1905.
Diagram No 6,—Showing Pressure at Hydraulic Main with No Seal, March 17.& 18. 1905.
Diagram No 7.—Showing Pressure at Retort Mouthpiece with No Seal. March, 17.& 18. 1905.

FIGS. 4, 5, 6, 7.—PRESSURE DIAGRAMS.

coal carbonized. This test has been made throughout the majority of the experiments.

The purified gas was analyzed in the following order: (*a*) Carbon dioxide estimated by absorption with strong caustic soda. (*b*) Hydrocarbons estimated by strong bromine. (*c*) Oxygen, by caustic soda and pyrogallic acid. (*d*) Carbon monoxide, by acid cuprous chloride. Owing to the multitude of the tests that had to be carried out day by day, it was found impossible to make a complete analysis of the purified gas for hydrogen, marsh gas, and nitrogen, as this would have occupied too large a portion of the chemists' time. The naphthalene was estimated in grains per 100 cubic feet of purified gas in the usual way by picric acid; and throughout the tests these estimations have been very accurate.

The cyanogen was estimated by passing 10 feet of crude gas from the outlet of the exhauster through a solution of strong caustic soda and sulphate of iron; and although these figures have been extremely erratic, the writer can vouch for their accuracy. From the calorific power of the purified mixed gases was estimated the gross and net British thermal units per ton of coal carbonized; and by deducting the B.T.U. obtained from the water gas, the gross and net B.T.U. derived solely from the coal were ascertained in each case. It was therefore possible to show the net increase or decrease of heating value derived from the coal due to the adoption of the water-gas process. To corroborate the figures as to the amount of sulphate of ammonia per ton of coal, the grains of ammonia were estimated per 100 cubic feet of crude gas.

In order to make quite sure that any increase in the cubic feet of coal gas per ton of coal when water gas was added was not due to the drawing in by the exhauster of an unduly large percentage of air or furnace gases, an analysis of the crude gas was made for oxygen and carbon dioxide at the outlet of the exhauster. The tests were taken in every case with the greatest possible care, and each series was continued until constant results were obtained. Throughout the whole of these experiments, no results have been considered as satisfactory unless they could be repeated at will. The writer determined first to test the coal alone under ordinary working conditions; but seeing that one hydraulic main was about to be closed up, and the water gas admitted into the top of the ascension pipes on the same side, causing it to pass down these pipes and to mix with the coal gas in its travel along the 18 feet retort and up the opposite ascension pipe, it was deemed necessary to carbonize the coal under similar conditions without the water gas, in order to obtain a proper and reliable basis on which to compare the loss or gain in the various items, due to the addition of water gas.

The testing of the coal alone under ordinary conditions proved quite satisfactory—in fact, an average make per ton for several days of about 12,000 cubic feet had been obtained. But immediately the coal was carbonized with one ascension pipe stopped, troubles began. The single 5-inch ascension pipe would not take double its normal quantity of gas; and that portion of the tests had to be abandoned because of stopped pipes. Afterwards blue water gas was passed into the blocked ascension pipe; and although on one or two days very striking results were obtained, these tests also had to be abandoned, because of the smallness of the pipes and the old-fashioned hydraulic main, in which it was impossible to avoid a tar seal.

After very persistent endeavours to make the plant work satisfactorily, it was finally found necessary to draw the fires; and the erection of new and larger hydraulic mains and pipes was decided upon. In designing the new iron-work, the author altered that on one side of the beds only, leaving the existing pipes and hydraulics on the other side as they were, and arranged that the five upper retorts only should be taken into the new hydraulic main; the pipes from the two bottom retorts being taken into the old hydraulic main, which was re-erected in front of the new one.

The new hydraulic main was of fairly large size, and was fitted with proper tar and liquor outlets and overflows, &c., and arranged for use with a "Delamore" tar column, which ensured a perfectly regular and constant liquor seal. The ascension pipes were 7 inches in diameter throughout. It was arranged to work only five retorts in the bed used for testing; so that, with charges of five hours' duration, one retort being charged every hour, a regular and constant flow of gas at every moment during the twenty-four hours would be obtained.

Experiments were resumed, with the surprising result that it was found that the new hydraulics and ascension

SERIES "A."—SOUTH YORKSHIRE SCREENED—PEA NUTS.

—	Coal Gas Alone, passing up One or Both Sides, with Sealed Dips.—1904.											Coal Gas Alone up One Side, no Seal.—1905.			Water Gas passing through Hydraulic Main with Sealed Dips.—1905.				
	Nov. 12.	Nov. 13.	Nov. 19.	Dec. 1.	Dec. 2.	Dec. 3.	Dec. 4.	Dec. 5.	Dec. 6.	Dec. 7.	Dec. 8.	Mar. 8.	Mar. 9.	Mar. 10.	Jan. 31.	Feb. 1.	Feb. 2.	Feb. 4.	Feb. 5.
Duration of test (hours)	24	24	24	23	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Number of charges (5-hour)	48	48	48	46	48	48	48	48	48	48	48	24	24	24	24	24	24	24	24
Weight per charge (cwt.)	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	4½	4½	4½	4½	4½	4½	4½	4½
	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.
Total weight	5 8 0	5 8 0	5 8 0	5 3 2	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0	5 8 0
Retorts	Good Heat	Good Heat	V.G. Heat	Good Heat	Good Heat	Fair Heat	Fair Heat	V.G. Heat	V.G. Heat	Good Heat	Good Heat	Moderate	Good Heat	V. Good	V.G. Heat	V.G. Heat	V.G. Heat	V.G. Heat	V.G. Heat
Gas made (mixed)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	78,300	100,800	88,700	91,000	100,000
,, ,, (corrected)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80,492	101,808	90,829	92,547	100,500
,, ,, (per ton)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16,261	18,853	16,820	17,138	18,611
Coal gas alone	65,100	61,500	63,300	59,600	61,300	60,800	60,100	64,000	62,000	65,400	61,900	65,800	62,400	65,900	—	—	—	—	—
,, ,, (corrected)	65,556	63,345	65,135	60,971	61,913	61,165	60,100	63,360	61,566	64,877	62,457	65,471	62,088	65,900	51,745	61,208	65,516	68,689	77,274
,, ,, (per ton)	12,140	12,240	12,062	11,782	11,465	11,237	11,130	11,733	11,401	12,014	11,566	12,124	11,498	12,204	10,453	11,335	12,133	12,720	14,310
Illuminating power	16·53	17·17	15·66	15·93	16·60	16·37	17·31	17·31	17·69	16·62	16·40	13 27	16·45	15 40	16·37	12·39	11·58	11·19	11 56
Sperm in lbs. per ton	688·02	720·55	647·62	643·48	652·52	630 68	660·55	696·34	691·48	684·59	650·34	552	648½	644½	913	801	668	657	738
Calorific power, gross—net	627–560	634–566	641–579	667–616	638–581	655–592	687–616	658–586	674–607	688–621	684–615	596–546	641–577	632–568	556–502	540–488	575–501	534–476	534–473
Water gas added (corrected)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29,730	41,986	25,313	24,672	24,019
,, ,, less CO_2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28,747	40,600	24,478	23,858	23,226
Per cent water gas added (crude)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	48·1	65·5	36·5	34·1	30
,, ,, ,, in bulk (pure)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	35·7	39·9	26·9	25·8	23·1
Calorific power of water gas	—	—	—	—	—	—	—	—	—	—	—	—	—	—	307–277	307–277	307–277	307–277	302–281
B.T.U. per ton from coal gas when using water gas (Gross)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7,351,081	7,793,695	8,232,407	7,749,009	8,594,978
B.T.U. per ton from coal gas when using water gas (Net)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6,638,137	7,046,589	7,229,275	6,892,075	7,553,115
B.T.U. per ton, total (Gross)	7,611,780	7,760,160	7,730,742	7,858,594	7,314,670	7,360,235	7,646,310	7,720,314	7,684,274	8,265,632	7,911,144	7,225,904	7,370,218	7,712,928	9,041,116	10,180,620	9,671,500	9,151,692	9,938,274
B.T.U. per ton, total (Net)	6,798,400	6,927,840	6,983,898	7,257,712	6,661,165	6,652,304	6,856,080	6,875,538	6,920,407	7,460,694	7,113,090	6,619,704	6,634,346	6,931,872	8,163,022	9,200,264	8,527,740	8,157,688	8,803,003
Crude gas per ton	12,350	12,515	12,271	11,961	11,628	11,407	11,311	11,923	11,563	12,184	11,778	12,789	11,964	12,819	16,938	19,639	17,521	17,964	19,266
Crude gas contains H_2S	1·05	1·5	1·1	0·9	1·0	1 0	1·3	1·2	1·2	1·1	1·4	3·2	2·5	3·0	2·6	2·4	2·5	3·2	2·0
,, ,, ,, CO_2	0·70	0·7	0·6	0·6	0·4	0·5	0·3	0·4	0·2	0·3	0·4	2·0	1·4	1·8	1·4	1 6	1·5	1·4	1·4
,, ,, ,, NH_3	79	75·9	75·3	30·4	58·5	53·7	67	81·7	71·07	85·48	92·6	31·5	61·57	24·72	6·5	0·5	6 5	11·56	16·33
Sulphur compounds, Grs. per 100 c. ft.	41·05	43·94	31·57	31 56	37·75	?	?	45·07	41·18	34·32	38·45	15·88	12·08	12·43	18·3	16·47	12·08	14·53	23·90
Cyanogen do. as KCN	?	200	—	166	170	125	124	87	203	201	—	100	103·5	132	106	106	—	130	—
Lbs. KCN per ton	—	3·57	—	2·73	2 82	2·03	2 00	1·48	3·35	3·50	—	1·83	1·77	2·41	2 56	2·97	—	3·34	—
Purified gas, specific gravity	·392	·356	·444	·360	·362	·351	·349	·352	·377	·364	·343	·431	·419	·388	·411	·422	·424	·454	·478
Analysis CO_2	0·2	0·8	—	—	0·5	2·8	1·2	0·2	1·8	—	—	1·4	1·6	1·8	1·0	0·8	0·2	0·8	0·6
Hydrocarbons	2·0	1 8	—	—	3·3	3·9	3·0	2·8	2·6	—	—	3 6	3·0	2·2	5·0	2·0	2·6	2 4	2·2
Paraffins	—	2·0	—	—	0·4	0·9	3 2	2·5	0·9	—	—	—	—	—	—,	—	—	—	—
O	0·8	0·4	—	—	2·6	0·7	1·4	2·0	1·7	—	—	1·0	1 3	1·2	1·0	1·2	1·0	1·0	1·0
CO	9·0	5·6	—	—	5·4	6·3	5·4	9·5	6·0	—	—	6·6	7·6	5·0	9·4	16·2	15·6	14·6	13·2
Hydrocarbons per ton cubic feet	242	220	?	?	378	438	334	328	296	—	—	436	345	268·5	813	377	?	411·3	409
Grains naphthalene per 100 cubic feet	—	—	—	—	—	—	—	—	—	18·6	—	36	32·7	22	18·4	20·8	—	16·0	– Alk.
Water gas, specific gravity	—	—	—	—	—	—	—	—	—	—	—	—	—	—	·570	·568	·562	·560	·570
H_2S and CO_2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·3	3·3	3·3	3·3	3·3
O	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·9	0·9	0·9	0·9	0·9
CO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	39·7	39·7	39·7	39·7	39·7
H_2CH_4 and N	—	—	—	—	—	—	—	—	—	—	—	—	—	—	56·1	56·1	56·1	56·1	56·1
Crude water gas used per ton of coal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5,505	7,775	4,687	4,569	4,448
Liquor produced	Reliable figures not obtained.			94	108	167	167	104	—	—	—	71	69	86	64	17	13	118	28
,, ,, per ton				18·16	20·0	30·92	30·92	19·26	—	—	—	13·1	12·8	15·9	11·9	3·1	2·4	21¼	5·2
Equivalent in lbs. S.A. per ton				15·29	16·85	25·06	25·06	16·23	—	—	—	11·0	10·8	13·4	10	2·6	2·0	17·9	4·4
Tar made (gallons)	Reliable figures not obtained.			—	64·26	85·68	85·68	85·68	78·54	85·68	85·68	64¼	78½	78½	85¾	85¾	85¾	85¾	85¾
,, ,, per ton (gallons)				—	11 9	15·87	15·87	15·87	14 54	15·87	15·87	11·9	14½	14½	16	16	16	16	16
	T. C. Q.		T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.
Coke made (total)	3 15 2	—	3 16 3	3 17 3	3 15 3	3 17 3	3 16 0	3 14 0	3 13 2	3 15 0	3 14 2	3 18 1	3 11 3	3 14 2	3 17 2	3 16 0	3 16 3	3 17 0	3 16 0
,, ,, per ton (cwt.)	14·00	—	14·21	15·02	14·03	14·40	14 07	13·84	13·61	13·89	13·79	14·5	13½	14	14·35	14 08	14·13	14 26	14·08
Remarks	Seal, 1 in. Vacuum on hydraulics, 4/10 Tar V. Reg.	Seal, 1 in. 4/10 Fair Reg.	Sal, 1 in. 4/10 V. Reg.	Seal, 1 in. 7/10 V. Reg.	Seal, 1½ in. 7/10 V. Reg.	Seal, 1½ in. 7/10 V. Reg. Difficulty with water condenser. Tar condenses at inlet of exhauster and chokes the mains.	Seal, 1½ in. 1/8 Reg.	Seal, 1 in. 7/10 Reg.	Seal, 1½ in 7/10 Reg.	Seal, 1 in. 1/8 Reg.	Seal, 1 in. 7/10 Reg.	Coal dirty; wet day.	Working regularly.						

SERIES "A."—SOUTH YORKSHIRE SCREENED—PEA NUTS (*continued*).

SERIES "A."—SOUTH YORKSHIRE SCREENED—PEA NUTS (*continued*).

—	Water Gas Through Hydraulic without Seal.—1905.				Water Gas passing through Retorts, with Sealed Dips.—1904.								Water Gas passing through Retorts, no Seal on Dips.—1905.				
	Mar. 10.	Mar. 12.	Mar. 13.	Mar. 14.	Dec. 14.	Dec. 15.	Dec. 16.	Dec. 17.	Dec. 18	Dec. 19.	Dec. 20.	Dec. 21.	Mar. 1.	Mar. 2.	Mar. 3.	Mar. 5.	Mar. 6.
Duration of test (hours)	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	18
Number of charges (5 hours)	24	24	24	24	48	48	48	48	48	48	48	48	24	24	24	24	18
Weight per charge (cwt.)	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	2½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 4 1 0
Total weight	V. G. Heat.	V. G. Heat.	V. G. Heat.	V. G. Heat.	Good Heat.	Good Heat.	Good Heat.	Good Heat.	Good Heat.	Good Heat.	Good Heat.	V. G. Heat.	V. G. Heat.	V. G. Heat.	V. G. Heat.	V. G. Heat.	V. G. Heat.
Retorts	96,300	111,100	87,100	84,600	79,900	73,300	73,800	73,100	67,800	66,200	67,400	73,000	87,400	84,000	78,200	85,900	67,300
Gas made (mixed)	94,470	108,767	85,097	82,654	80,459	74,033	74,686	73,246	68,003	68,649	70,770	75,847	88,361	85,596	80,702	87,103	67,300
,, ,, (corrected)	17,494	20,142	15,758	15,306	14,900	13,710	13,831	13,564	12,593	12,713	13,105	14,046	16,363	15,851	14,945	16,130	16,617
,, ,, (per ton)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Coal gas alone	61,414	67,902	65,063	64,403	59,017	58,267	59,066	56,082	56,264	56,471	59,857	66,062	63,469	64,848	62,250	62,539	49,049
,, ,, (corrected	11,373	12,574	12,049	11,926	10,929	10,790	10,938	10,385	10,419	10,459	11,085	12,234	11,754	12,009	11,528	11,581	12,111
,, ,, (per ton)	11·34	8·68	12·56	12·82	15·58	16·23	15·68	16·22	15·65	15·20	15·69	13·46	14·82	14·11	13·85	14·02	11·58
Illuminating power	680	599½	678·6	673	795·91	762·9	743·55	754·31	690·57	662 53	704·97	648·2	831	767	710	775	660
Sperm in lbs. per ton	556–506	514–466	590–535	587–530	622–560	622–562	647–583	640–577	584–522	614–555	614–549	596–537	573–518	593–529	562–497	550–484	539–489
Calorific power, gross—net	34,433	42,391	20,956	19,051	21,791	15,766	16,203	17·164	12,016	12,548	11,182	10,109	25,983	21,501	19,505	25,857	18,700
Water gas added (corrected)	33,056	40,865	20,034	18,251	21,442	15,356	15,620	16,769	11,739	12,171	10,913	9,785	24,892	20,748	18,452	24,564	18,251
,, ,, less CO_2	57·4	59·6	30·7	28·4	36·2	26·5	27·1	30·1	20·9	21·9	18·4	15·1	39·9	32·1	30·2	39·6	36·1
Per cent. water gas added (crude)	35·0	37·6	23·5	22·1	26·6	20·7	20·9	22·9	17·3	17·7	15·4	12·9	28·2	24·2	22·8	28·2	27·1
,, ,, ,, in bulk (pure)	335–306	330–300	335–306	333–305	343–312	333–306	338–312	330–302	319–290	324–292	321–292	320–290	323–279	323–279	323–279	330–297	338–307
Calorific power of water gas	7,590,369	7,762,488	7,997,085	7,809,788	7,883,668	7,580,667	7,934,469	7,568,828	6,822,609	7,022,902	7,381,762	7,772,364	7,821,723	8,168,084	7,232,414	7,290,460	7,396,017
B.T.U. per ton from coal gas when using water gas { Gross	6,900,602	7,031,172	7,242,954	7,036,140	7,084,965	6,834,847	7,127,300	6,990,158	6,087,712	6,377,194	6,589,989	6,999,811	7,133,486	7,312,732	6,419,917	6,384,884	6,708,294
Net	9,726,664	10,352,988	9,297,220	8,984,622	9,267,800	8,527,620	8,948,657	8,593,600	7,516,080	7,805,782	8,046,470	8,371,416	9,375,999	9,409,050	8,399,090	8,871,500	8,956,563
B.T.U. per ton, total { Gross	8,851,964	9,386,172	8,430,530	8,112,180	8,344,000	7,705,020	8,063,473	7,927,980	6,718,140	7,055,715	7,194,645	7,542,702	8,476,034	8,384,650	7,427,665	7,806,920	8,125,713
Net	18,261	21,025	16,500	15,944	15,188	13,947	14,056	13,743	12,876	12,946	13,318	14,245	16,870	16,685	15,563	16,873	17,400
Crude gas per ton	2·8	2·2	2·9	3·2	1·3	1·0	1·0	1·0	1·2	1·4	1·1	1·0	2·0	1·9	2·0	2·8	2·5
Crude gas contains H_2S	1·4	2·0	1·6	1·4	0·6	0·7	0·6	0·3	1·0	0 4	0·5	0·4	1·0	1·3	2·0	1·6	2·0
,, ,, ,, CO_2	85·5	43·2	49·5	48·6	95·0	86·0	46·62	131	135	37·8	69·57	104	11·18	18·7	17·23	33·5	—
,, ,, ,, NH_3	13·7	26·72	—	3·8	—	46·62	40·64	148	—	—	24·71	—	14·64	13·3	26·73	26·84	27·46
Sulphur compounds { Grs. per	111	61	Test	88	162·5	104	131	21·17 ?	209	191	157	198	116	313·5	97	32	27
Cyanogen do. as in KCN { 100 c.ft.	2 89	1·83	Spoilt.	2·0	2·58	2·07	2·63	—	3·84	3·60	2·99	4·06	2·8	7·3	2·16	·77	·64
Lbs. KCN per ton	·464	·488	·418	·420	·525	·414	·384	·408	·432	·418	·471	·418	·451	·512	·476	·486	—
Purified gas, specific gravity	2·0	1·0	2·4	1·4	0·6	0·8	2·0	1·0	0 6	0·6	—	—	2·7	2·8	1·0	2·0	1·4
Analysis CO_2	2·5	2·4	2·7	2·6	2·4	3·0	3·0	3·3	3·2	3·4	—	—	3·6	2·2	3·2	2·4	2·6
Hydrocarbons	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Paraffins	0·8	0·8	0·9	1·4	1·3	1·0	1·6	1·0	1·6	1·6	—	—	1·0	1·0	0·8	1·3	1·4
O	15·5	17·4	13·4	12 8	13·1	12·8	11·4	12·0	13·6	13·2	—	—	16·5	13·6	14·2	14·7	14·8
CO	451	483	425	398	262	324	328	343	333	355	—	—	589	349	478	387	432
Hydrocarbons per ton cubic feet	37·5	18·6	40·0	—	—	—	—	—	15·4	15·0	7·0	17·8	? Test	alkaline,	?	27·8	—
Grains naphthalene per 100 cubic feet	·568	·528	·545	·552	·548	·542	·531	·545	·540	·542	·581	·563	·552	·569	·558	·551	—
Water gas, specific gravity	4·0	3·6	4·4	4·2	1·6	2·6	3·6	2·3	2·3	3·0	2·4	3·2	4·2	3·5	5·4	5·0	2·4
H_2S and CO_2	0·4	0·6	0·5	0·6	1·8	0·8	1·0	0·6	0·8	0·7	0·3	0·2	0·6	1·3	0·4	0·2	0·6
O	41·8	37·0	39·7	39·8	39·0	40·8	39·2	39·5	38·3	38·1	37·8	38·0	41·2	40·8	39·6	39·4	40·6
CO	53·8	58·8	55·4	—	—	—	—	—	—	—	—	—	54·0	54·4	53·6	55·4	56·4
H_2 CH_4 and N	6,377	7,850	3,881	3,528	4,035	2,919	3,000	3,178	2,223	2,225	2,323	2,070	4,812	3,842	3,612	4,788	4,617
Crude water gas used per ton of coal	52	27	88	121	50	50	27	99	87	96	110	78	28	108	54	50	47
Liquor produced	9 63	5	16	22½	9·26	9·26	5·36	18·33	16·11	17·78	20·37	14·44	5·2	20	10	9½	11·5
,, ,, per ton	8·1	4·2	13½	19	7·8	7·8	4·52	15·44	13·47	14·98	17·16	12·16	4·4	16·8	8·4	7·8	9·7
Equivalent in lbs. S.A. per ton	85·68	85·68	85·68	85·68	85·68	85·68	85·68	85·68	85·68	85·68	85·68	85·68	64	78	85¾	71	78
Tar made (gallons)	15·87	15·87	15·87	15·87	15·87	15·87	15·87	15·87	15·87	15·87	15·87	15·87	11·8	14·4	16	13·1	14·4
,, ,, per ton (gallons)	78½	85¾	78½	85¾	—	—	—	—	—	—	—	—	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.
	14½	16	14½	16	—	—	—	—	—	—	—	—	3 16 3	3 18 0	3 18 1	3 19 1	3 18 0
Coke made (total)	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.							14·13	14·44	14·5	14·68	14·44
,, ,, per ton (cwt.)	3 14 1	3 15 0	3 13 3	3 14 3	3 14 0	3 14 0											
	13·75	14·0	13·6	13·8	13·84	13·74											
Remarks					Seal, 1½ in. 1/10. V. Reg.	Seal, 1½ in. 1/10 V. Reg.	Seal, 1½ in. 1/10 Reg.	Seal, 1½ in. 1/10 V. Reg.	Seal, 1½ in. 1/10 V. Reg.	Seal, 1½ in. 1/10 Reg.	Seal, 1½ in. 1/10 V. Reg.	Seal, ⅜ in. 1/10. Vacuum on retorts, 5/10. Very regular.					

SERIES "B."—FIRST-CLASS CANNEL.

—	With Seal working up both sides.		With Seal working up one side.		Coal alone, without Seal.			Water Gas through Hydraulic Main, with Seal.			Water Gas through Hydraulic Main no Seal.			Water Gas through Retorts, with Seal.		Water Gas through Retorts, no Seal.	
	1905--Jan. 14.	Jan. 15.	Jan. 16.	Jan. 17.	Mar. 17.	Mar. 18.	Mar. 19.	Jan. 22.	Jan. 23.	Jan. 24.	Mar. 20.	Mar. 21.	Mar. 22	Jan 20.	Jan. 21.	Mar. 23.	Mar. 24.
Duration of test (hours)	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Number of charges (5-hour)	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Weight per charge (cwt.)	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½
Total weight	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0
Retorts	Good average working heat.	Good average heat.	Good average working heat.	Good average working heat.	Good working heat.	Good working heat.	Good working heat.	Good working heat.	Good average heat.	Good working heat.	Good working heat.	Good working heat.	Very good working heat.	Good working heat.	Good working heat.	Very good heat.	Very good.
Gas made (mixed)	—	—	—	—	—	—	—	79,300	73,200	72,500	80,800	86,000	84,000	73,300	81,500	81,500	89,600
,, ,, (corrected)	—	—	—	—	—	—	—	82,631	75,616	75,037	81,366	84,796	84,000	76,965	85,086	79,870	87,629
,, ,, (per ton)	—	—	—	—	—	—	—	15,302	14,003	13,896	15,068	15,703	15,555	14,253	15,757	14,792	16,228
Coal gas alone	59,700	58,100	58,500	58,800	60,100	61,700	67,900	—	—	—	—	—	—	—	—	—	—
,, ,, (corrected)	61,680	59,436	59,085	60,270	58,898	60,774	67,425	60,364	59,541	59,544	60,519	63,608	63,199	55,575	66,779	57,695	59,545
,, ,, (per ton)	11,422	11,007	10,942	11,161	10,907	11,254	12,486	11,178	11,026	11,027	11,207	11,780	11,704	10,292	12,366	10,684	11,027
Illuminating power	18·70	20·08	20·37	20·00	20·84	21·60	18·18	14·87	17·45	16·70	17·26	18·00	16·44	17·41	14·74	18·23	16·78
Sperm in lbs. per ton	732·2	758	764	765	779	833	778	723	838	796	892	969	877	851	796	924½	933·6
Calorific power, gross—net	717–648	738–666	719–648	817–746	758–689	770–699	650–597	650–592	704–640	681–617	591–538	617–562	616–561	679–607	642–584	642–591	613–559
Water gas added (corrected)	—	—	—	—	—	—	—	22,768	16,497	15,939	21,650	21,889	21,400	21,871	18,719	22,932	29,438
,, ,, less CO_2	—	—	—	—	—	—	—	22,267	16,075	15,493	20,847	21,188	20,801	21,390	18,307	22,175	28,084
Per cent. water gas added (crude)	—	—	—	—	—	—	—	34·9	25·8	25·5	33·2	32·2	32·2	36·5	26·2	37·4	46·0
,, ,, in bulk (pure)	—	—	—	—	—	—	—	26·9	21·2	20·6	25·6	25·0	25·0	27·8	21·5	27·8	32·0
Calorific power of water gas	—	—	—	—	—	—	—	339–308	320–293	320–293	328–302	334–306	322–296	339–308	339–308	330–302	317–289
B.T.U. per ton from coal gas when using water gas. Gross	—	—	—	—	—	—	—	8,517,076	8,880,512	8,518,632	7,590,236	8,334,715	8,305,794	8,304,837	8,941,020	8,094,954	8,219,797
Net	—	—	—	—	—	—	—	7,760,256	8,066,805	7,708,984	6,895,866	7,584,562	7,553,307	7,404,171	8,134,550	7,459,478	7,496,113
B.T.U. per ton, total Gross	8,189,574	8,123,166	7,867,298	9,118,537	8,267,506	8,665,580	8,115,900	9,946,300	9,858,112	9,463,176	8,905,188	9,688,751	9,581,880	9,677,787	10,115,994	9,496,464	9,947,764
Net	7,401,456	7,330,662	7,090,416	8,226,106	7,514,923	7,866,546	7,454,542	9,058,784	8,961,920	8,573,832	8,106,584	8,825,086	8,726,355	8,651,571	9,202,088	8,742,072	9,071,452
Crude gas per ton	11,948	11,635	11,518	11,773	11,457	11,799	13,426	16,348	14,899	14,566	16,064	16,634	16,271	15,195	16,761	15,603	17,301
Crude gas contains H_2S	2·4	2·8	2·6	3·2	2·3	2·2	2·4	3·2	3·2	2·2	4·6	3·6	2·6	4·2	4·0	3·2	3·8
,, ,, ,, CO_2	2·0	2·6	2·4	2·0	2·5	2 4	4·6	3·2	3 2	2·4	1·6	2·0	1·8	2·0	2·0	2·0	2·4
,, ,, ,, NH_3	—	3·8	3·8	4·87	33·2	29·8	36·39	1·1	2·0	0·87	41·92	32·0	39·3	2·2	12·9	39·3	17·47
Sulphur compounds (Grains per 100 cub. ft.)	18·5	22·32	23·23	21 20	29·28	21·12	11·43	16·47	29·5	13·72	8·53	8·5	13·73	13·16	16·47	20·5	10·55
Cyanogen as KCN	—	193	166	—	(?)	158	102	191	91·5	114·5	134	Unreliable.	105	—	—	No test	250
Lbs. KCN per ton	—	3·21	2·73	—	(?)	2·66	1·95	4·47	1·94	2·38	3·07		2·44	—	—	(?)	6·2
Purified gas, specific gravity	·346	·470	·435	·465	·471	·484	·557	·532	·475	·504	·507	·504	·573	·494	·534	·508	·507
Analysis CO_2	0·5	0·8	1·2	1·6	2·0	1·0	1·0	0·6	0·3	0·4	1·4	1·6	1·4	—	0·5	1·4	1·0
Hydrocarbons	7·1	6·4	8·0	6·4	8·8	9·0	7·4	·2	6·1	6·0	6·6	6·2	7·0	6·4	6·5	6·6	6·6
O	0·2	0·3	0·0	0·8	0·4	1·2	1·8	0·1	0·1	0·2	0·7	1·4	2·0	—	0·3	2·8	1·4
CO	7·2	7·5	7·0	7·6	9·2	8·6	7·7	15·7	15·0	14·2	16·7	15·2	14·8	—	13·0	15·8	17·4
Hydrocarbons per ton cubic feet	811	704·5	875	714	960	1013	924	949	854	833	994	974	1089	912	1024	976	1071
Grains naphthalene per 100 cubic feet	—	27·75	28·0	23·5	23·3	5·0 (?)	17·0	27·06	41·2	23·15	9 6	9·3	12·8	23·5	27·15	7·0	9·6
Crude water gas added per ton	—	—	—	—	—	—	—	4216	3055	2952	4009	4054	3963	4050	3466	4247	5451
Water gas, specific gravity	—	—	—	—	—	—	—	·544	·544	·544	·574	·547	·573	·566	·566	·566	·547
H_2S and CO_2	—	—	—	—	—	—	—	2·2	2·8	2·8	3·8	3·6	2·8	2·2	2·2	3·3	4·6
O	—	—	—	—	—	—	—	0·8	Trace.	Trace.	0·4	0·4	0·4	0·8	0·8	0·5	0·8
CO	—	—	—	—	—	—	—	38 0	37·2	37·2	39·4	40·4	39·6	38·0	38·0	40·5	38·8
H_2, CH_4 and N	—	—	—	—	—	—	—	59·0	60·0	60·0	56·4	55 6	57·2	59·0	59·0	55·7	55·8
Liquor produced (gallons 10 ozs.)	130	130	149	Unreliable.	127	130	135	148	148	107	123	98	117	115	201	120	121
,, ,, per ton	24	24	27½		23½	24	25	27½	27½	20	22⅜	18	21½	21	37	22¼	22½
Equivalent in lbs. S.A. per ton	20¼	20¼	23¼		19 8	20¼	21	23	31	16⅜	19	15·1	18·1	17½	31	18 7	18·9
Tar made (gallons)	128·5	135½	142·8	Unreliable.	129	135	129	171	171	164	129	135	135	171½	178½	129	121
,, ,, per ton (gallons)	24	25	26½		24	25	24	32	32	30½	24	25	25	32	33	24	22½
Coke made (total)	T. C. Q. 3 3 0	T. C. Q. 3 4 0	T. C. Q. 3 4 2	T. C. Q. 3 4 0	T. C. Q. 3 3 0	T. C. Q. 3 3 2	T. C. Q. 3 3 0	T. C. Q. 3 3 2	T. C. Q. 3 4 0	T. C. Q. 3 3 0	T. C. Q. 3 2 2	T. C. Q. 3 4 0	T. C. Q. 2 18 2	T. C. Q. 3 3 2	T. C. Q 3 2 0	T. C. Q. 3 2 2	T. C. Q. 3 2 0
,, ,, per ton (cwt.)	11·7	11·9	11·9	11·9	11·7	11·8	11·7	11·8	11·9	11·7	11·6	11·8	10·8	11·8	11·5	11·6	11·5
Remarks	Regular working. Seal, ½ in.	Regular working. Seal, ½ in.	Regular working. Seal, ½ in.	Regular working. Seal, ½ in.							Working regularly.			Quantity of water gas per hour varied somewhat, due to varying pressures in the retort. Seal, ½ in. to ¾ in.		Working regularly. Two ascension pipes slightly stopped and quickly cleared.	

SERIES "C."—LOCAL CANNEL.

	Coal Alone, Gas up One or Both Sides.				Water Gas through One Hydraulic.		Hot Water Gas passing through Hydraulic Main.				Water Gas passing through Retorts.				Average of Six Days.
	1905.—Feb. 7.	Feb. 8.	Feb. 9.	Feb. 14.	Feb. 12.	Feb. 13.	Feb. 20.	Feb. 21.	Feb. 23.	Feb. 24.	Feb. 15.	Feb. 17.	Feb. 26.	Feb. 27.	
Duration of test	24	24	24	24	24	24	24	24	24	24	24	24	24	24	—
Number of charges (5-hour)	24	24	24	24	24	24	24	24	24	24	24	24	24	24	—
Weight per charge (cwt.)	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	4½ T. C. Q. 5 8 0	—
Total weight	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Retorts	—	—	—	63,200	65,700	63,600	54,600	56,000	58,900	58,000	58,500	57,500	62,100	56,500	—
Gas made (mixed)	—	—	—	64,970	68,394	65,317	56,893	58,500	61,374	59,508	59,962	58,362	62,100	56,726	11,003
,, ,, (corrected)	—	—	—	12,031	12,666	12,096	10,536	10,837	11,365	11,020	11,104	10,808	11,500	10,505	—
,, ,, (per ton)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Coal gas alone	45,500	45,500	45,900	45,048	47,684	45,654	44,789	46,080	48,202	46,791	43,178	43,250	45,746	42,828	—
,, ,, (corrected)	47,638	47,320	47,139	8,342	8,830	8,454	8,294	8,533	8,926	8,665	7,996	8,009	8,471	7,931	7,968
,, ,, (per ton)	8,822	8,763	8,730	19·64	19·88	19·63	19·55	19·74	19·22	20·28	20·42	20·57	20·07	21·42	20·27
Illuminating power	20·69	22·55	23·75	810	863	814	740½	733	749	766	777½	762	791	773	765
Sperm in lbs. per ton	626	677	711	664–603	665–605	662–600	672–616	696–626	704–645	681–624	694–632	709–645	681–620	711–630	708–644
Calorific power, gross—net	738–671	814–733	791–715	20,971	22,173	21,053	12,608	12,958	13,650	13,030	17,630	15,742	17,000	14,357	16,147
Water gas added (corrected)	—	—	—	19,922	20,710	19,663	12,104	12,440	13,172	12,717	16,784	15,112	16,354	13,898	15,498
,, ,, less CO_2	—	—	—	47·6	45·2	41·9	28·4	26·6	26·1	25·9	37·2	33·3	36·5	31·7	37·2
Per cent. water gas added (crude)	—	—	—	30·7	30·0	30·1	21·3	21·3	21·5	21·4	28·0	25·9	26·3	24·5	27·5
Per cent. water gas in bulk (pure)	—	—	—	322–295	293–263	322–295	291–265	291–265	319–291	319–291	333–305	333–305	333–305	333–305	333–305
Calorific power of water gas	—	—	—	6,738,258	7,219,830	6,752,074	6,400,717	6,844,152	7,194,528	6,734,873	6,618,931	6,692,177	6,785,880	6,583,608	6,794,454
B.T.U. per ton from coal gas when using water gas { Gross	—	—	—	6,109,208	6,583,052	6,107,395	5,871,401	6,247,962	6,594,777	6,174,297	6,021,903	6,082,085	6,172,300	5,807,156	6,173,982
Net	—	—	—	7,988,584	8,422,890	8,007,552	7,080,192	7,542,552	8,000,960	7,504,620	7,706,176	7,662,872	7,831,500	7,469,055	7,790,124
B.T.U. per ton total { Gross	6,510,636	7,133,082	6,905,430	7,254,693	7,662,930	7,257,600	6,490,176	6,783,962	7,330,425	6,876,480	7,017,728	6,971,160	7,130,000	6,618,150	7,085,932
Net	5,919,561	6,423,279	6,241,950	12,964	13,194	13,205	11,185	11,407	12,194	11,749	12,043	11,697	11,735	11,058	11,780
Crude gas per ton	9,548	9,463	9,489	2·22	5·26	1·32	1·34	1·42	1·04	·61	1·15	·85	1·38	·65	6·6
Crude gas contains H_2S	4·8	4·8	5·0	5·0	2·0	5 1	2·8	3·4	3·6	3·6	5·0	5·2	3·8	3·0	—
CO	2·8	2·6	3·0	2 2	2·0	3·3	3·0	1·6	3·2	2·6	2·8	2·4	2·0	2·0	—
Grains per 100 cubic feet of NH_3	10·6	12·94	4·95	44·54	23·82	16 84	16·4	18·0	17·1	13·75	—	—	10·48	12·23	—
Sulphur compounds, grains per 100 cubic feet	20 03	12·19	20·75	21·96	18·30	27 46	8·24	8·9	10·97	8·91	26·4	7·83	15·36	10·98	—
CN as KCN, grains per 100 cubic feet	96	32	No blue formed	120	279	70	89	92	64	38·7	67	51·2	84·4	43·2	—
Lbs. KCN per ton	—	·43	—	2·22	5·26	1·32	1·34	1·42	1·04	·61	1·15	·85	1·38	·65	—
Purified gas, specific gravity	·531	·531	·537	·517	·520	·514	·523	·520	·534	·534	·562	·556	·556	·548	—
Analysis: CO_2	1·2	1·6	2·0	2·4	1·0	2·8	1·4	1·8	1·8	2·0	2 0	1·6	2·6	1·0	—
Hydrocarbons	8·6	10·4	10·8	8·2	8·2	8·4	7·6	8·6	8·8	9·0	8·0	9·4	8·2	10·0	8·9
O	0·4	2·9	0·2	1·1	1·2	1·4	0·9	2·0	1·4	0·4	1·1	0·9	0·9	0·9	—
CO	8·8	13·5	7·2	17·7	18·2	16·8	15·9	15·6	15·8	16·0	17·1	16·7	14·9	14·3	16·1
Hydrocarbons per ton	758·7	911·3	942·8	986	1,038·6	1,016	801	932	1,000	992	888	1,016	937	1,050	979
Grains naphthalene per 100 cubic feet	No test	14	(?)	59·3	40	—	73·4	74·9	64·2	43·9	66	87·5	58 5	66·4	—
Water gas, specific gravity	—	—	—	·577	·619	·562	·592	·588	·534	·534	·588	·572	·573	·583	—
H_2S and CO_2	—	—	—	5·0	6·6	6·6	4·0	4·0	3·5	2·4	4·8	4·0	3·8	3·2	—
O	—	—	—	1·2	0·4	0·9	0·9	0·4	0·5	0·4	0·9	0·8	0·4	0·6	—
CO	—	—	—	40·4	36·8	39·3	39·6	39·4	41·2	42·0	41·0	39·8	40·8	40·6	—
H_2CH_4 and N	—	—	—	53·4	56·2	53·2	55·5	56·2	54·8	55·2	53·3	55·4	55·0	55·6	—
Crude water gas used per ton of coal	—	—	—	3,899	4,068	4,106	2,335	2,400	2,528	2,413	3,265	2,915	3,140	2,659	2,990
Liquor produced	108	213	128	200	128	216	122	123	124	90	173	128	90	90	—
Liquor produced per ton	20	39½	23¾	37	23¾	40	22½	22¼	23	16⅝	32	23¾	16⅝	16⅜	—
Equivalent in lbs. S.A. per ton	16·8	33½	20	31¼	20	33¾	19	19	19⅓	14	27	20	14	14	19
Tar made, gallons	100	143	129	108	93	114	100	108	114	121	100	108	108	121	—
Tar made, per ton } specific gravity = 1·152 {	18½	26½	24	20	17½	21	18½	20	21	22½	18½	20	20	22½	19·9
				T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	—
Coke made	(?)	(?)	(?)	3 10 2	3 8 0	3 12 0	3 10 0	3 13 0	3 9 2	3 9 0	3 10 0	3 5 2	3 6 0	3 7 0	—
,, ,, per ton	—	—	—	13·06	12·6	13·3	12·96	13·52	12·87	12·78	12·96	12·04	12·22	12·41	—
Remarks	Sealed dips throughout the series.				Regular working all through the tests.										

SERIES "D."—DERBYSHIRE UNSCREENED GAS COAL.

	Coal Alone, with Seal.			Coal Alone, no Seal.			Water Gas through Hydraulic, with Seal.			Water Gas through Hydraulic, no Seal.			Water Gas through Retorts, with Seal.		Water Gas through Retorts, no Seal.		
	1905—Mar. 31.	April 1.	April 2.	Mar. 28.	Mar. 29	Mar. 30.	April 4.	April 5.	April 6.	April 12.	April 13.	April 14.	April 7.	April 8.	April 9.	April 10.	April 11.
Duration of test (hours)	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Number of charges (5-hour)	24	24	24	24	24	23	24	24	24	24	24	24	24	24	24	24	24
Weight per charge (cwt.)	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½
Total weight	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 3 2	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0	T. C. Q. 5 8 0
Retorts	Heats very good.			Heats very good.			Heats good.	Heats good.	Heats good.	Good average heats.			Heats good.	Heats good.	Good average working heat.		
Gas made (mixed)	—	—	—	—	—	—	77,600	80,000	77,300	86,100	82,600	94,000	78,000	77,000	85,500	88,600	82,100
,, ,, (corrected)	—	—	—	—	—	—	76,824	80,000	77,300	84,120	78,883	91,180	78,624	77,616	85,500	85,942	78,816
,, ,, (per ton)	—	—	—	—	—	—	14,226	14,815	14,315	15,578	14,608	16,885	14,560	14,373	15,833	15,915	14,595
Coal gas alone (uncorrected)	64,700	63,000	62,600	69,100	72,400	67,100	—	—	—	—	—	—	—	—	—	—	—
,, ,, ,, (corrected)	64,700	63,315	62,162	69,307	72,038	67,100	61,270	63,700	61,750	67,800	63,395	59,204	62,208	61,843	69,107	70,118	67,860
,, ,, ,, (per ton)	11,982	11,725	11,511	12,835	13,340	12,966	11,346	11,796	11,435	12,370	11,740	10,964	11,520	11,452	12,798	12,985	12,567
Illuminating power	14·05	14·86	15·96	15·98	12·82	13·02	13·78	12·25	12·89	11·95	13·54	10·83	12·44	13·24	11·56	10·83	12·61
Sperm in lbs. per ton	577	597	630	703·2	586	579	672	622	633	638	678	627	621	652	627	591	631
Calorific power, gross—net	592-535	607-544	629-570	630-566	554-505	557-501	597-541	585-527	596-541	550-504	584-532	544-500	589-534	541-488	547-498	512-468	573-529
Water gas added (corrected)	—	—	—	—	—	—	16,236	16,300	16,300	17,000	16,235	33,659	17,136	16,430	16,900	16,587	12,480
,, ,, less CO_2	—	—	—	—	—	—	15,554	15,713	15,550	16,320	15,488	31,976	16,416	15,773	16,393	15,824	11,956
Per cent. water gas added (crude)	—	—	—	—	—	—	25	24·3	24·8	24·0	24·1	55	26·0	25·0	23·3	22·4	17·7
,, ,, ,, ,, in bulk (pure)	—	—	—	—	—	—	20	19·6	20·1	19·4	19·6	35	20·9	20·3	19·2	18·4	15·2
Calorific power of water gas, gross—net	—	—	—	—	—	—	327-302	330-302	326,300	327-299	332-304	326-298	324,300	325,301	330-306	320-290	328-304
B.T.U. per ton from coal gas when using water gas. Gross	—	—	—	—	—	—	7,509,960	7,706,175	7,547,872	7,537,400	7,533,080	7,153,482	7,547,788	6,786,818	7,627,751	7,165,440	7,604,927
B.T.U. per ton from coal gas when using water gas. Net	—	—	—	—	—	—	6,788,454	6,895,465	6,839,015	6,906,627	6,857,632	6,585,066	6,823,140	6,098,081	6,927,054	6,557,340	7,018,211
B.T.U. per ton total Gross	7,093,344	7,117,075	7,240,419	8,086,050	7,390,360	7,219,834	8,492,922	8,666,775	8,531,740	8,567,900	8,531,072	9,185,440	8,575,840	7,775,793	8,660,651	8,148,480	8,362,935
B.T.U. per ton total Net	6,410,370	6,378,400	6,561,270	7,264,610	6,736,700	6,493,962	7,696,266	7,807,505	7,744,415	7,851,312	7,771,456	8,442,500	7,775,040	7,014,024	7,884,834	7,448,220	7,720,755
Crude gas per ton	12,534	12,394	12,091	13,398	14,131	13,819	15,038	15,465	15,196	16,296	15,474	17,552	15,359	15,193	16,527	16,753	15,395
Crude water gas used per ton of coal.	—	—	—	—	—	—	3,006	3,020	3,018	3,148	3,006	6,233	3,173	3,043	3,130	3,072	2,311
Crude gas contains H_2S	2·8	3·6	3·0	2·6	3·6	3·8	3·2	2·8	3·4	2·8	3·0	2·0	3·6	4·0	2·4	3·6	3·0
,, ,, ,, Oxygen	—	—	—	—	—	—	1·6	1 6	1·4	0·8	1·6	1·8	1·6	1·1	1·8	1·4	1·6
,, ,, ,, CO_2	1·6	1·8	1·8	1·6	2·0	2·4	2·2	1·4	2·4	1·6	2·6	1·8	1·6	1·4	1·8	1·4	2·2
,, ,, ,, NH_3 Grains per 100 c.f.	45·8	60·0	45·8	24·19	20·96	20·70	32·75	20 96	16·84	50·4	52·4	135·0	49·3	35·92	33·54	41·4	37·84
Sulphur compounds Grains per 100 c.f.	50·82	46·7	28·84	37·17	56·62	46·24	39·81	13·19	39·23	60·66	41·72	45·50	33·34	53·14	57·1	43·35	29·30
Cyanogen do. as KCN	386?	188	30	—	51	139	479	Test spoilt.	—	133	147	98	240	161	8·0	247	229
Lbs. KCN per ton	6·91?	3·3	0·51	—	1·03	2·74	10·2	—	—	3·1	3·2	2·3	5·3	3·4	0·2	7·3	5·4
Purified gas, specific gravity	·464	·475	·482	—	·492	·497	·488	·441	·518	·508	·456	·476	·526	520	·521	·518	·518
Analysis CO_2	0·8	0·8	0·6	1·4	0·6	1·2	1·0	0 8	1·6	0·6	1·2	0·8	2·0	0·4	0·4	1·0	1·4
Hydrocarbons	3·4	3·6	3·0	3·8	3·4	3·2	3·2	3·2	3·2	3·0	3·2	1 9	3·5	3·0	2·6	2·2	3·0
O	1·0	0 9	0·8	2·2	2·0	1·4	0·8	1·0	0·8	0·4	0·6	1·5	0·8	1·0	1·2	1·2	0·8
CO	7·8	8·7	8·0	9·6	8·2	8·2	13·6	14·0	14·6	15·0	14·4	19·2	12·8	13·9	12·2	12·0	10·8
Hydrocarbons per ton	407	422	345	488	453	415	455	474	458	467	467	321	510	431	411	350	438
Grains naphthalene per 100 cubic feet	20	10	10·5	20·8	17	10·5	12	8·5	13	17	16	7·3	15·0	17	14	12·5	12·2
Water gas, specific gravity	—	—	—	—	—	—	·541	·598	·572	·588	·548	·550	·580	·584	·583	·583	·582
H_2S and CO_2	—	—	—	—	—	—	4·2	3·6	4·6	4·0	4·6	5 0	4·2	4·0	3·0	4 6	4·2
O	—	—	—	—	—	—	0·4	0·8	0·8	1·0	0·4	0·3	0·4	0·0	0·4	0·6	0·6
CO	—	—	—	—	—	—	40·4	39·8	39·8	39·6	40·4	40·3	39·6	41·0	38·8	39·0	40·4
H_2 CH_4 and N	—	—	—	—	—	—	55·0	55·8	54·8	55·4	54·6	54 ·4	55·8	55·0	57·8	55·8	54·8
Liquor produced (10 ozs.)	118	101	75·8	149	119	Liquor figs.	133	80	141	120	81	157	122	125	167	115	96
,, ,, per ton	22	18·7	14	27·6	22·0	unreliable	24½	15	26	22½	15	29	22½	23	31	21½	18
Equivalent in lbs. S.A. per ton	18½	15¾	11·8	23·25	18·5	for this day.	20½	12½	22	18¾	12½	24½	19	19·4	26	18	15
Tar made (gallons)	71½	85¾	78½	71½	78½	71½	71½	78½	71½	71½	78½	71½	78½	78½	85¾	78½	85¾
,, ,, gallons per ton	13¼	15¾	14½	13¼	14½	13¼	13¼	14½	13¼	13¼	14½	13¼	14½	14½	16	14½	16
Coke made (total)	T. C. Q. 3 7 1	T. C. Q. 3 7 3	T. C. Q. 3 8 1	T. C. Q. 3 10 0	T. C. Q. 3 9 2	T. C. Q. 3 8 2	T. C. Q. 3 7 0	T. C. Q. 3 7 3	T. C. Q. 3 6 3	T. C. Q. 3 7 1	T. C. Q. 3 8 0	T. C. Q. 3 8 2	T. C. Q. 3 8 1	T. C. Q. 3 6 0	T. C. Q. 3 7 0	T. C. Q. 3 8 2	T. C. Q. 3 7 1
,, ,, per ton (cwt.)	12·4	12·5	12·6	13·0	12·9	12·7	12·4	12·5	12·4	12·4	12·6	12·6	12·6	12·2	12·4	12·6	12·4
Remarks	Regular working.			Reg. working all through these tests.			Working regularly.			Regular working.			Regular working.		Working regularly.		
Flame length at high rate—inches	3·5	4·0	3 8	—	—	3·75	3·0	3·0	3·0	3·3	3·0	—	3·0	3·2	3·5	3·0	3·5
,, ,, 5 ft. ,, ,,	2·0	2·2	2·0	—	—	1·8	2·0	2·0	1·8	1·5	1·8	—	1·8	1·6	1·5	1·5	1·8
Illum. power at 5-ft. rate—candles	—	—	—	—	—	—	—	—	—	8 25	10·46	6·71	9·58	9·35	7·23	4·75	9·0

TABLE A.—SUMMARY OF DAILY TESTS WITH SOUTH YORKSHIRE COAL.

—	Old Conditions.	Coal Alone.		Water Gas through Hydraulic.		Water Gas through Retorts.	
		With Seal.	Without Seal.	With Seal.	Without Seal.	With Seal.	Without Seal.
Gas made per ton—	(0)	(1)	(2)	(3)	(4)	(5)	(6)
Mixed gas, cubic feet	..	..	..	17,537	17,175	13,558	15,981
Coal gas only ,,	11,222	11,704	11,942	12,190	11,980	10,905	11,797
Illuminating power, candles	15·95	16·69	15 04	12 62	11·35	15·46	13 68
Sperm pounds per ton	613	669	607	716	658	720	749
Net calorific power, B.T.U.	..	594	564	488	509	555	503
Total net B.T.U. per ton—							
Coal gas alone, millions	..	6·95	6·73	7·07	7·05	6·76	6·79
Mixed gas ,,	..	..	..	8 57	8·69	7·57	8·04
Purified gas—							
Carbon dioxide, per cent.	..	1·10	1·60	0·70	1·70	0·90	2·00
Oxygen, ,,	..	1·40	1 20	1·00	1·00	1·30	1·10
Hydrocarbons, ,,	..	2·80	2·90	2·80	2·55	3·00	2·80
Carbon monoxide, ,,	..	6·70	6·40	13·80	14·80	12·70	14·80
Specific gravity of gas	..	0·368	0·413	0·438	0·448	0·434	0·481
Hydrocarbons per ton, cubic feet	..	319	350	399	439	324	447
Crude water gas added, per cent.	..	..	..	42·80	44·00	24·50	35 60
Water gas in bulk—							
Percentage	..	..	..	30 30	29·50	19·30	26·10
Cubic feet used per ton of coal	..	..	..	5219	5241	2634	4168
Water gas—							
Specific gravity	..	..	..	0 566	0·548	0·549	0·557
Carbon dioxide, per cent.	..	..	..	3·30	4 00	2·60	4·10
Oxygen ,,	..	..	..	0·90	0·50	0·80	0·60
Carbon monoxide ,,	..	..	..	39·70	39·60	38·80	40·30
Tar—							
Gallons per ton	8½	15·10	13·60	16·00	15·25	15 87	13·90
Specific gravity	..	1·220	1·250	?	?	Not obtainable	Too stiff
Pounds of sulphate of ammonia per ton	..	19·7	11·7	7·40	11·20	11·70	9·40
Number of tests	..	11	3	5	4	8	5
Net calorific power of crude water gas, B.T.U.	..	..	..	278	304	300	288
Total B.T.U. due to water gas added, millions	..	..	..	1·50	1·64	0·81	1·25
Crude water gas used per ton of coal, cubic feet	..	..	..	5397	5409	2704	4334

pipes (on one side of the bed only) made no difference whatever in the results obtained; results being the same whether the gas went up one side or both. There was, however, a striking increase shown in the pounds of sperm and gallons of tar per ton when carbonizing South Yorkshire coal under the new and altered conditions. Carbonizing with the altered plant was found to be very much more satisfactory. The results were extremely regular and uniform throughout; and with the same coal, practically the same results were obtained day by day. This will be noticed from the tests of November 12, 13, and 18, when 12,140 and 12,240 cubic feet of gas of 16·53 and 17·17 candle power respectively per ton of coal were obtained.

The carbonization of the coal alone worked extremely satisfactorily; but immediately water gas was added, either in the hydraulic main or in the retorts, the greatest possible difficulty was experienced in obtaining reliable and constant results. With the addition of water gas in the hydraulic main there was obtained either too much pull on the water gas or on the ascension pipes; and "despite the good and complete gas equipment and the exactness of the observations made," and despite the untiring energy and perseverance of everyone concerned, it certainly appeared as though no better fate awaited the Nottingham experiments than that accorded to those of Herr Dicke; and the writer almost despaired of bringing the tests to a satisfactory conclusion.

It was, however, decided to make a few minor alterations in the plant, and to try a retort-house governor. Immediately this was done and the governor put to work, it was found that practically all troubles were overcome. Since then there has been very little difficulty in the regulation of the amount of exhaust, and it has been possible to regulate the percentage of water gas to within 1 per cent. of any desired quantity.

A.—Tests with South Yorkshire Coal.

Having got the plant into perfect working order, a commencement was made with the commonest grade of a well-known South Yorkshire gas coal. Excellent carbonizing results were obtained, which, as regards the make of gas and pounds sperm per ton, showed an improvement on any results hitherto obtained from the same coal.

Water gas was then admitted into the hydraulic main, with the result that an increase was obtained in the cubic feet of coal gas per ton, the pounds sperm, and also the gallons of tar—the results were, in fact, very satisfactory. When, however, water gas was added in the retorts, the make of gas per ton fell considerably, with a corresponding increase in the sperm pounds per ton; the tar remaining in this case about the same. The most striking feature appeared to be the increase in the sperm, accompanied at the same time with an increase in the gallons of tar per ton, and also in the cubic feet of hydrocarbons per ton. This was entirely contrary to expectation; and although having considerable faith in the reliability and accuracy of the results being obtained, the writer felt he could not at once accept the figures with regard to the increased quantity of tar, &c., from the coal. He therefore took the precaution of verifying them.

The whole of the tar is collected in as few seal-pots as possible, and finally runs into a small tar-well, from which it is pumped day by day into a small measuring tank, where it is measured, and the results taken therefrom. This increase in the tar obtained is contrary to the results that were set forth at Glasgow by Professor Lewes, who suggested that the quantity of tar would decrease, but that it would be heavier and of a thicker consistency, and that the sulphate of ammonia would increase (as one would expect) in similarity with the ammonia results obtained by reducing the temperature of reaction as in the Mond gas process. Samples of the tar made were carefully taken day by day, and tested accurately by distillation. After experimenting for some time, the author decided to have, in addition to the recording pressure gauge in the hydraulic main, a second gauge fixed on the retorts themselves, so as to ascertain the exact pressure existing in the retorts under the then working conditions, which were approximately ½-inch liquor seal on the dips and about ½-inch suction in the hydraulics.

As shown in the diagrams already mentioned, for the first hour after the charge the pressure in the retorts amounted to as much as 25-10ths to 35-10ths, falling gradually to about 10-10ths during the second hour, to level gauge at the end of the third hour; and during the fourth and fifth hours a slight vacuum was occasionally indicated. This appeared to be the exact converse of what was desired; for when the best and the greatest bulk of the gases were being liberated, there was the greatest back-pressure and the most adverse circumstances. On the other hand, when the poorest of the gas was coming off, there was a level gauge or a slight vacuum. If these conditions could have been reversed, the results would certainly have been much more satisfactory; but this seemed practically impossible.

Obviously the best course to adopt was to use the anti-dip arrangement of baffles, which had been provided for in

TABLE B.—SUMMARY OF DAILY TESTS WITH FIRST-CLASS CANNEL.

—	Old Conditions.	Coal Alone.		Water Gas through Hydraulic Main.		Water Gas through Retorts.	
		With Seal.	Without Seal.	With Seal.	Without Seal.	With Seal.	Without Seal.
Gas made per ton—	(0)	(1)	(2)	(3)	(4)	(5)	(6)
Mixed gas, cubic feet	..	..	..	14,400	15,442	15,005	15,510
Coal gas only ,,	10,194	11,169	11,549	11,077	11,564	11,329	10,855
Illuminating power, candles	22·10	19·79	20·21	16·34	17·23	16·08	17·50
Sperm pounds per ton	772	756	797	786	913	824	929
Net calorific power, B.T.U.	..	677	662	616	554	595	575
Total net B.T.U. per ton—							
Coal gas alone, millions	..	7·51	7·61	7·85	7·34	7·76	7·48
Mixed gas, ,,	..	..	..	8·86	8·55	8·92	8·90
Purified gas—							
Carbon dioxide, per cent.	..	1·0	1·3	0·4	1·4	0·5	1·2
Oxygen, ,,	..	0·3	1·1	0·1	1·3	0·3	2·1
Hydrocarbons, ,,	..	7 0	8·4	6 1	6·6	6·5	6·6
Carbon monoxide, ,,	..	7·3	8·5	15·0	15·6	13·0	16·6
Specific gravity of gas	..	0·429	0·504	0·504	0·528	0·514	0·507
Hydrocarbons per ton, cubic feet	..	784	966	879	1019	962	1023
Crude water gas added, per cent.	..	..	..	28·7	32·5	31·3	41·7
Water gas in bulk—							
Percentage	..	..	..	22·9	25·2	24·6	29·9
Cubic feet used per ton of coal	..	..	..	3323	3879	3676	4654
Water gas—							
Specific gravity	..	..	..	0·544	0·565	0·566	0·566
Carbon dioxide, per cent.	..	..	..	2·6	3·4	2·2	4·0
Oxygen, ,,	..	..	..	0·3	0·4	0·8	0·6
Carbon monoxide, ,,	..	..	..	37 5	39·8	38·0	39·7
Tar—							
Gallons per ton	17¾	25	24	32	25	32	23
Specific gravity	..	1·190	..	1·200	..	1·195	..
Pounds of sulphate of ammonia per ton	..	21·25	20·35	23·6	17·4	24·25	18 8
Number of tests	..	4	3	3	3	2	2
Net calorific power of crude water gas, B.T.U.	..	..	..	298	301	308	295
Total B.T.U. due to water gas added millions	..	..	..	1·01	1·21	1·16	1·43
Crude water gas used per ton of coal, cubic feet	..	..	..	3408	4009	3758	4849

designing the new hydraulics; but although the exhauster was very accurately automatically regulated, it was found to be impossible until the retort-house governor was put to work. With the use of this governor, it was found quite possible to work without seals and without baffles in the ascension pipes; and there was actually an open pipe from the retort mouthpiece to the inlet of the exhauster. Finding this possible, the author forthwith essayed to test the South Yorkshire coal without a seal. The effect was very satisfactory, improved carbonizing results being obtained; and it was found that in almost every case, as might have been expected from an examination of the pressure-gauge diagrams the removal of the adverse back-pressure during the first three hours gave considerable increase in the make of gas and in the cubic feet of hydrocarbons per ton.

After successfully carbonizing without seals or baffles, the writer proceeded to test each coal in the following six ways: (1) Alone with ½-inch liquor seal. (2) Alone with no seal. (3) With water gas added in the hydraulic main with seal. (4) The same without seal. (5) With water gas passing through the full length of retorts with seal. (6) The same without seal. The results are presented in this form.

The alteration made in the methods of working, whereby a perfectly constant liquor seal and a minimum of back-pressure in the retorts were maintained greatly improved the results. An increase of about 9 per cent. in the sperm per ton, accompanied by an increase of nearly 50 per cent. in the yield of tar, was obtained, although any appreciable diminution in the yield of coke could not be detected. These were the highest figures ever attained for this particular coal; and it could reasonably be supposed that the utmost value was now being obtained from it, and that if any further improvement was shown by the adoption of the water-gas process, it would be actually due to the addition of water gas and not attributable to any improvements or better working conditions in the carbonization of the coal alone.

As already stated, a commencement was made with the commonest grade of a well-known South Yorkshire coal, which was tested in each of the above-mentioned six methods. The average of all the previous tests, when carbonizing in this same plant, gave a make per ton of 11,222 cubic feet of 15·95-candle power gas (equivalent to 613 lbs. of sperm) and 8½ gallons of tar. But under the new conditions, the average yield per ton of coal was 11,704 cubic feet of gas of 16·69-candle power (669 lbs. of sperm) and 15·1 gallons of tar.

	New Conditions.		Old Conditions.
Make per ton	11,704 candles	..	11,222 candles.
Candle power	16·69	..	15·95
Sperm per ton	669 lbs.	..	613 lbs.
Tar per ton	15·1 gallons	..	8½ gallons.

The summary appended of the series of daily tests with the South Yorkshire coal shows the advantages and disadvantages of the various methods of carbonizing.

Coal alone, WITH *Seal*.—Under column 1, eleven tests were made, giving varying results, as will be seen from the daily records which are also presented herewith. Although a very high yield of gas per ton was obtained throughout this series, the crude gas never contained more than 0·7 per cent. of carbon dioxide, which is a clear indication that furnace gases were not being drawn in with the gas. The sulphate of ammonia remained fairly regular, and the tar was remarkably uniform throughout the whole period, and with two exceptions the sperm remained very constant indeed.

Coal alone, WITHOUT *Seal*.—At a later date, when carbonizing this same coal without a seal (A 2), an increase was obtained of 238 cubic feet in the make of gas per ton on the results obtained when working with a seal. There was, however, a loss of 62 lbs. in the sperm, and a loss of 0·22 million British thermal units. The hydrocarbons increased from 319 to 350 cubic feet per ton. The tar fell from 15·1 to 13·6 gallons per ton; and the yield of sulphate of ammonia was also less by 8 lbs. per ton. This drop in the sperm was at first naturally attributed to air being drawn in at the retort mouthpiece, or carbon dioxide through the pores of the retorts; but the analyses of the crude and purified gases did not show any appreciable difference in these respects. To make perfectly certain, several samples of the gas were taken at the outlet of the exhauster (the nearest point to the retort where pressure would be found), and were carefully analyzed for oxygen and carbon dioxide; but again no serious difference was discernible. The analysis of the purified gas showed, however, an increase from 1·1 per cent. to 1·6 per cent. of carbonic acid. The oxygen, on the other hand, was actually lower, and fell from 1·4 per cent. to 1·2 per cent. The carbonic oxide also showed a diminution of 0·3 per cent.; and the tar, which was less in quantity, was slightly higher in specific gravity, and of a thicker consistency.

Water Gas through Hydraulic Main, WITH *Seal*.—When water was added in the hydraulic main with sealed dip-pipes (A 3), an average yield of 12,190 cubic feet of coal gas (the water gas, 5397 cubic feet per ton, having been

TABLE C.—SUMMARY OF DAILY TESTS WITH INFERIOR LOCAL CANNEL.

½-Inch Seal all through.

—	Average of Previous Tests.	Coal alone with Seal.	Water Gas through Hydraulic Main.	Hot Water Gas through Hydraulic Main.	Water Gas through Retorts.
	(0)	(1)	(3)	(3a)	(5)
Make per ton of mixed gas, cubic feet		..	12,264	10,939	11,003
,, ,, coal ,, ,, ,,		8,772	8,542	8,584	7,968
Illuminating power, candles		22·33	19·72	19·70	20·27
Sperm lbs. per ton		671	829	747	765
Calorific power gross, B.T.U.		814	663	688	708
,, ,, net, ,,		706	603	628	644
Total B.T.U. per ton mixed gas gross, millions		..	8·14	7·53	7·79
,, ,, ,, ,, net, ,,		..	7·39	6·87	7·08
,, ,, ,, coal gas gross, ,,		6·85	6·90	6·79	6·79
,, ,, ,, ,, net, ,,		6·19	6·27	6·22	6·17
Purified gas—					
Carbon dioxide, per cent.		1·6	2·1	1·7	1·9
Oxygen, ,,		1·1	1·2	1·2	0·8
Hydrocarbons, ,,		9·9	8·3	8·3	8·9
Carbon monoxide, ,,		8 0	17·6	15·8	16·1
Specific gravity of purified gas		0·533	0·517	0·528	0·553
Hydrocarbons per ton, cubic feet		870	1,014	931	979
Crude water gas added, cubic feet		..	4,024	2,419	2,990
Do. per cent..		..	44·9	26·7	37·2
Pure water gas added, cubic feet		..	3,740	2,335	2,870
Do. in bulk, per cent.		..	30·3	21·4	27·5
Water gas—					
Specific gravity		..	0·586	0·562	0·576
Carbon dioxide, per cent.		..	6·1	3·5	3·8
Oxygen, ,,		..	0·8	0·5	0·9
Carbon monoxide, ,,		..	38·8	40·5	40·6
Tar, gallons per ton		23	16·5	20½	19·9
Sulphate of ammonia, pounds per ton		23½	28½	18	19
Number of tests		3	3	4	6
Net calorific of water gas, B.T.U.		..	284	278	305
Total B.T.U. due to water gas added, millions		..	1·13	0·66	0·91
Added per ton of coal		..	..	..	..

deducted), 716 lbs. of sperm, and 16 gallons of tar per ton were obtained. In fact, with regard to the coal, the writer was "getting more out of the retort than had been put into it;" for, in spite of this increased yield, it was not possible to detect any decrease whatever in the yield of other residuals. The total purified mixed gas per ton averaged 17,537 cubic feet; the illuminating power was 12·62 candles; and the sperm 716 lbs., or a gain of 47 lbs. on the coal alone with a seal (A 1). The net B.T.U. per ton of coal for the coal gas alone showed a slight increase. The sulphate of ammonia showed a further fall to 7·4 lbs. per ton. On the other hand, the hydrocarbons per ton increased from 319 to 399 cubic feet.

With water gas through the hydraulic main working with a seal (A 3), there was thus an increase in the sperm, an increase in the cubic feet per ton, a reduction in the candle power, a gain in the heat units, a diminution in the sulphate of ammonia, and an increase from 15·10 to 16 gallons of tar per ton of coal. The remarkable feature appeared to be that, with the addition of water gas in the hydraulic mains, there was an increase in the make per ton, an increase in the sperm, and an increase of 6 per cent. in the tar; and the writer is still at a loss to understand why the addition of water gas in this portion of the plant should have any effect on the formation of tar. It must be borne in mind that the figures submitted in this column are the average results of five days' working.

Water Gas through Hydraulic Main, WITHOUT *Seal.* — Water gas was then added to the coal gas at the end of each hydraulic main, working with no seal (A 4). The make per ton was 11,980 cubic feet; the illuminating power 11·35 candles; and the sperm 658 lbs. The hydrocarbons per ton showed a very considerable increase, the highest figure so far reached—namely, 439 cubic feet. Although 44 per cent. of water gas (5409 cubic feet per ton) was added, the net calorific power of the mixed gases was 509 B.T.U. The net B.T.U. per ton of coal due to coal gas was 7·05 millions, 0·10 million higher than when working with the coal alone with a seal (A 1). The carbon dioxide per ton reached approximately the same figure as when working the coal without a seal (A 2); and the oxygen was slightly lower in the purified gases. The carbon monoxide increased over the figure obtained when working with water gas in the hydraulic main with a seal (A 3), 1 per cent. [When working without a seal it is usually found that the carbon monoxide increases by about 1 per cent. in the gases.] There was a diminution in the sulphur compounds and the naphthalene. The cyanogen remained practically the same. The tar fell from 16 gallons with a seal, to 15¼ gallons without a seal. The sulphate of ammonia increased from 7·4 to 11·2 lbs.

Water Gas through Retorts, WITH *Seal.* — On adding water gas in the retorts with sealed dip-pipes (A 5) the make of coal gas per ton fell to 10,905 cubic feet; but the sperm rose to 720 lbs.—a gain of 51 lbs. on the coal alone working with a seal (A 1). As compared with column 4, the tar and the sulphate of ammonia remained about the same, the cubic feet of hydrocarbons per ton fell very considerably; but the illuminating power increased to 15·46 candles. On the other hand, the total B.T.U. per ton due to coal gas alone fell to 6·76 millions, although the net calorific power of the gas was 555 B.T.U. The tar obtained was so stiff that it was impossible to ascertain its specific gravity by ordinary methods. It was of the consistency known as "ropy." Owing to the diminution in the percentage of water gas added, which had fallen to 24½ per cent., the total mixed gases per ton fell to 13,558 cubic feet.

Water Gas through Retorts, WITHOUT *Seal.* — Water gas was next passed through the retorts with no seal (A 6). The make of coal gas increased to about the normal figure. The sperm pounds per ton reached the highest figure so far attained with this coal, as did also the cubic feet of hydrocarbons; and although only 35 per cent. of crude water gas was added, the purified gas contained 14·8 per cent. of carbon monoxide, compared with 13·8 per cent. when 42·8 per cent. was added, working with water gas through the hydraulic main with a seal (A 3). The B.T.U. per ton due to coal gas alone were slightly lower when working under normal conditions, but higher than when working coal alone without a seal (A 2). The tar remained exceedingly stiff, and only 13·9 gallons per ton were obtained. Sulphate of ammonia also fell to the lowest figure on record, with one exception.

B.—TESTS WITH FIRST-CLASS CANNEL.

Having spent considerable time with the South Yorkshire coal, tests of first-class cannel were proceeded with. Under the new conditions—that is, with a slight liquor seal, high heats, and perfect control of the exhaust—the yield of gas increased; but the sperm fell considerably. It was surprising to find that the tar increased most abnormally. The following figures are in each case averages of several tests:—

	B1. New Conditions.		Bo. Old Conditions.
Make per ton	11,169 cubic feet.	..	10,194 cubic feet.
Candle power.	19·79	..	22·10
Sperm per ton	756 lbs.	..	772 lbs.
Tar per ton	25 gallons.	..	17¾ gallons.

Coal alone, WITHOUT *Seal.*—On working the cannel with no seal (B 2), an increase in every item with the exception of tar and sulphate was obtained—in fact, an increase of

TABLE D.—SUMMARY OF DAILY TESTS WITH DERBYSHIRE UNSCREENED GAS COAL.

—	Old Conditions.	Coal Alone.		Water Gas through Hydraulic Main.		Water Gas through Retorts.	
		With Seal.	Without Seal.	With Seal.	Without Seal.	With Seal.	Without Seal.
	(0)	(1)	(2)	(3)	(4)	(5)	(6)
Gas made per ton—							
Mixed gas, cubic feet		..	..	14,452	15,690	14,466	15,449
Coal gas only ,,		11,739	13,153	11,526	11,691	11,486	12,783
Illuminating power, candles		14·96	12·92	12·97	12·11	12·84	11·67
Sperm pounds per ton		601	533	642	648	636	616
Gross calorific power, B.T.U.		609	556	593	559	566	544
Net ,, ,, ,,		550	503	536	512	511	498
Total B.T.U. per ton mixed gas gross, millions		..	..	8·36	8·76	8·17	8·39
,, ,, ,, ,, net ,,		..	..	7·75	8·02	7·39	7·68
,, ,, ,, coal gas alone, gross ,,		7·15	7·57	7·59	7·41	7·17	7·46
,, ,, ,, ,, ,, net ,,		6·45	6·61	6·84	6·78	6·46	6·84
Purified gas—							
Carbon dioxide, per cent.		0·8	0·9	1·1	0·9	1·2	0·9
Hydrocarbons, ,,		3·3	3·3	3·2	2·7	3·2	2·6
Carbon monoxide, ,,		8·2	8·2	14·1	16·2	13·3	11·7
Oxygen, ,,		0·9	1·7	0·9	0·8	0·9	1·1
Specific gravity of gas		0·474	0·494	0·482	0·480	0·523	0·519
Hydrocarbons per ton, cubic feet		391	434	462	418	470	400
Crude water gas added ,,		..	..	3015	4129	3108	2837
,, ,, ,, ,, per cent.		..	..	24·7	34·4	25·5	21·1
Pure water gas added, cubic feet		..	..	2890	3935	2980	2727
,, ,, ,, in bulk, per cent.		..	..	20·2	24·7	20·6	17·6
Water gas—							
Specific gravity		..	..	0·570	0·562	0·582	0·583
Carbon dioxide, per cent.		..	..	4·1	4·5	4·1	3·9
Oxygen, ,,		..	..	0·7	0·6	0·2	0·5
Carbon monoxide, ,,		..	..	40·0	40·1	40·3	39·4
Tar, gallons per ton		14·5	14	13⅜	13⅜	14·5	15·5
Pounds of sulphate of ammonia per ton		15·25	18·5	18⅛	18·58	19·2	19¾
Number of tests		3	2	3	3	2	3

No previous tests recorded.

380 cubic feet of gas, 0·42 candle, 41 lbs. of sperm, 0·1 million B.T.U., and 182 cubic feet in the hydrocarbons per ton of cannel carbonized. The carbon monoxide increased by 1·2 per cent., the oxygen by 0·8 per cent., the carbon dioxide by 0·3 per cent. in the purified gas. The total make per ton was 11,549 cubic feet of 20·21-candle power.

Water Gas through Hydraulic Main, WITH *Seal.* — On adding water gas in the hydraulic with a seal (B 3), a slight loss compared with the standard (B 1) was noticed in the make per ton—viz., 92 cubic feet, a gain of 30 lbs. of sperm (from 756 to 786 lbs.), and an increase in the B.T.U. (from 7·51 to 7·85 millions), and an increase of 95 cubic feet of hydrocarbons per ton; while the tar reached the very abnormal figure of 32 gallons per ton, the sulphate of ammonia showing a small increase.

Water Gas through Hydraulic Main, WITHOUT *Seal.* — With water gas in the hydraulic with no seal (B 4), again a big increase in the make per ton was recorded, a very large increase in the pounds of sperm per ton, a slight decrease in the B.T.U., and a very large gain indeed in the cubic feet of hydrocarbons per ton; but a falling back to the new normal figure with regard to the tar.

Water Gas through Retorts, WITH *Seal.*—With water gas in the retorts with a seal (B 5), the make per ton showed only a small increase; the pounds of sperm, a great increase on coal alone with seal (B 1); but a reduction, as compared with the water gas in the hydraulic with no seal (B 4). The B.T.U. showed considerable gain. The hydrocarbons also greatly increased, but were again lower than B 4; and the tar again reached the abnormal figure of 32 gallons per ton.

Water Gas through Retorts, WITHOUT *Seal.* — With water gas in the retorts without seal (B 6), the make per ton fell very considerably. The sperm, however, rose to 929 lbs.—the highest figure so far recorded. The B.T.U. dropped to the lowest figure (with the exception of B 4). The hydrocarbons reached the record amount of 1023 cubic feet per ton; and the tar fell to 23 gallons, or 2 gallons lower than the cannel alone under the new normal conditions (B 1).

With a seal, there does not appear to be so great a yield of hydrocarbons per ton as without one. But, on the other hand, there is an abnormal increase in the gallons of tar per ton, which reaches a most unusual figure. It appears therefore that what is lost in the pounds of sperm and the hydrocarbons is, in some cases, made up in the yield of tar. But, strange to say, in the case of B 5 and B 3, there is a big increase in the sperm, the B.T.U., the hydrocarbons, and at the same time in the tar.

Throughout these tests it will be noticed that the figures for cyanogen, naphthalene, and ammonia have been somewhat erratic. This fluctuation is not due to any lack of reliability in the estimations, but solely to the vagaries of the process. In some of the previous experiments, it was found that the sulphate of ammonia had fallen from 32 lbs. per ton to as low as 3 lbs. per ton. Cyanogen had also fluctuated in much the same way. Naphthalene varied considerably, both in the gases and tars; and the author's impressions in this respect, formed from previous experiments at Ilford, are confirmed by the results here obtained. It should be noticed, from the analysis of the gas, that the carbonic oxide usually increases by 1 per cent. when working with no seal, and that the greatest gain in heating value is usually obtained when the coal is worked with a seal. Many matters of very great interest, but too numerous to mention in detail, have arisen in connection with these tests.

TESTS WITH INFERIOR LOCAL CANNEL.

In the series of tests recorded in Table C, with the inferior local cannels, there are very few figures which call for special notice. Compared with all previous records of tests, the new carbonizing arrangements gave an increase in the cubic feet of gas, with a decrease in the pounds of sperm per ton. Seeing that there was only a small yield of very rich quality gas per ton of cannel, the effect of running heated water gas into the hydraulic main was tried; but no improvement in the results was found. It is worth mentioning, however, that the naphthalene in the purified gas on one occasion reached the abnormal figure of 83 grains per 100 cubic feet. In this series of tests, the cyanogen was extremely low. The sulphate of ammonia varied very considerably, both when using and when not using water gas; but the tar remained practically the same.

TESTS WITH DERBYSHIRE UNSCREENED GAS COAL.

After trying South Yorkshire coal (Table A), a first-class cannel (Table B), and a local cannel (Table C), and with the object of making the results as complete and as universally applicable as possible, the author wrote Mr. Shoubridge, of Sydenham, who was kind enough to tell him the name of the coal used at his works in the experiments conducted by Professor Lewes. About 200 tons of coal exactly similar to it in all respects was forthwith purchased. Very great care was exercised in loading the coal; and, on arrival, it was well mixed and stored in the coal-sheds adjoining the testing plant, in order to protect it from the weather, and to ensure that the results throughout the series of experiments should be as reliable and as accurate as possible.

The General Manager of the Colliery gave the assurance that the coal sent was, to all intents and purposes, the same as that used at the Sydenham Gas-Works in August, 1900. Instead, however, of getting a yield of only 10,468 cubic

feet per ton of 15·88 candles, or 33,246 candle-feet per ton of coal, the author obtained, with this same coal, working under the new conditions (D 1) 11,739 cubic feet of 14·96-candle power, or 35,103 candle-feet. Working without a seal, the same coal yielded (D 2) 13,153 cubic feet of 12·92-candle power, or 33,987 candle-feet for the coal alone.

It will be noticed from Table D that a gain is shown under every head throughout the series of tests, with the exception of the tars, and in the case of the B.T.U. per ton, when the water gas was passed through the retorts with a seal (D 5). Unfortunately, this description of coal had not previously been carbonized at Nottingham, and, consequently, no reliable data on which to base the improvement effected by the new conditions of carbonizing was available. But accepting Professor Lewes's figures of 10,468 of 15·88-candle power, it will be noticed that a very considerable improvement is shown as compared with them.

Coal alone, WITHOUT *Seal*.—On working this coal alone with no seal (D 2), a very considerable increase in the cubic feet per ton was at once registered, with a reduction of two candles in the illuminating power. The B.T.U. per ton increased nearly 6 per cent.; the hydrocarbons per ton increased very considerably; but a slight decrease was noted in the tar, counterbalanced by a fairly large increase in the sulphate of ammonia per ton, which was to a certain extent contrary to expectations. With water gas in the hydraulics when working with a seal (D 3), the make per ton fell somewhat; but again the sperm value showed a further increase of 6·82 per cent. above the basis given in column I. The calorific power fell somewhat on the coal alone with a seal (D 1), but showed a large increase on the coal alone without a seal (D 2). The total net B.T.U. per ton from the coal alone showed an increase of 0·39 million on the standard (D 1). The hydrocarbons per ton, however, went up very considerably, from 391 to 462 cubic feet. The tar showed a slight decrease. But, on the other hand, the sulphate of ammonia increased from 15½ to 18⅓ lbs. per ton.

Water Gas through Hydraulic Main, WITHOUT *Seal*.—With water gas in the hydraulics, with no seal (D 4), the make per ton remained practically the same. The sperm value increased about 8 per cent. on the basis. The B.T.U. showed very considerable increase, as did also the hydrocarbons. The sulphate of ammonia increased somewhat; but a slight diminution was noticed in the tar.

Comparing the figures relating to water gas through the hydraulic with a seal (D 3) with those of the hydraulic without seal (D 4), the pounds of sperm per ton are 642 and 648 respectively, the B.T.U. per ton 6·84 and 6·78, the hydrocarbons per ton 462 and 418, the tar 13⅜ and 13⅜, and the sulphate of ammonia 18⅓ and 18¼.

Water Gas through Retorts, WITH *Seal*.—With water-gas through the retorts with a seal (D 5) working in the same manner as Professor Lewes at Sydenham, the make per ton showed a slight decrease on the basis—a decrease from 11,739 cubic feet with the coal alone with a seal (D 1) to 11,486 cubic feet with the water gas through the retorts with a seal (D 5). The sperm pounds per ton showed an increase from 601 to 636—approximately 6 per cent. The B.T.U. per ton increased from 6·45 to 6·46 millions. The hydrocarbons per ton increased very considerably. The tar remained constant. The sulphate of ammonia showed an increase from 15·25 to 19·2 lbs. per ton.

Working with water gas in the retorts with no seal (D 6), the make per ton showed a still further increase from 11,739 feet (D 1) to 12,783 feet (D 6). The sperm was hardly so satisfactory as when working under the same conditions with a seal; but it still remained above the basis. The B.T.U. (net), however, increased to the highest figure recorded for this series of tests—namely, from 6·45 to 6·84 millions per ton. The hydrocarbons per ton increased from 391 cubic feet to 400 cubic feet; but with this exception is the lowest figure for this series of tests. The tar reached the highest figure recorded in this series of tests (Table D)—namely, 15·5 gallons per ton. The sulphate of ammonia showed a considerable increase on the basis.

After completing the above experiments of Series D, it was decided to pass a very large quantity of water gas through the hydraulic main, and to note the results. Some 55 per cent. of water gas was added, or about 35 per cent. in the bulk. The make per ton at once fell to the lowest figure so far recorded with this coal—namely, 10,964 cubic feet (April 14, 1905). The candle power was 10·83 candles; the sperm value 627 lbs. per ton. The B.T.U. per ton showed a slight increase on the basis (from 6·45 to 6·58 millions); but the hydrocarbons per ton fell very considerably, from 391 to 321 cubic feet. Tar showed a very slight decrease; and the sulphate of ammonia reached 24·25 lbs. per ton.

Throughout the whole of this series of tests (D) with Derbyshire coal, the regularity in the yield of pounds sperm per ton was very striking. On two separate days—viz., March 23 and 31—13,340 cubic feet and 11,725 cubic feet of 12·82 and 14·86 candle power respectively were recorded. This showed that, in spite of the great difference in the cubic feet of gas per ton, of over 1600 cubic feet, the sperm-pounds per ton remained practically the same—viz., 586 lbs. and 597 lbs. The B.T.U. per ton, due to coal gas alone, throughout this series showed a very considerable gain with the addition of water gas, as did also the hydrocarbons. The tar remained fairly constant, and the sulphate of ammonia showed no very great improvement, with the exception of April 9, with water gas (23 per cent.) through the retorts and no seal (D 6), when the sulphate of ammonia reached 26 lbs. per ton of coal. These further tests are of particular interest, as they also were made with exactly the same kind of coal as that experimented upon by Professor Lewes at Sydenham, and under somewhat similar conditions.

Throughout the whole of this paper the writer is presenting a plain statement of absolute fact, and is avoiding any theorizing or any attempt to suggest a reason or explanation for the somewhat unique results, preferring to leave this to abler people. It is conclusively shown that, with the addition of water gas, there is in practically every case a considerable increase in the yield of products from the coal. In some cases the cubic feet of coal gas per ton increases abnormally; and as high a figure as 14,310 cubic feet has been registered.

The sperm per ton shows a very large increase in one or two cases. Take for example in Series B, with first-class cannel (columns 4 and 6), when a gain is shown on the basis (B 1) of 21 and 23 per cent. respectively; and the B.T.U. per ton also show considerable increase. In the case of the hydrocarbons, the increase is most marked, however, and particularly with the cannel working with water gas in the retorts and in the hydraulics with no seal (B 4 and B 6), when the increase amounts to over 30 per cent.; and in the case of Series A, with South Yorkshire coal (columns 4 and 6), when the increase reached 38 per cent.

Tar.

By far the most striking feature of the tests, from an experimental point of view, was the abnormal increase in the gallons of tar per ton when passing water-gas into the hydraulics and into the retorts with a seal when carbonizing cannels (Table B, columns 3 and 5). For several days in succession the enormous figure of 32 gallons of tar per ton was recorded; and even had this tar proved to be practically all pitch, yet, compared with the normal figure of 18 gallons per ton, there would still be a great increase in the profits under this head.

Throughout the whole of these experiments, a sample of the tar made each day has been carefully retained for analysis. This has been tested in a stamped steel still capable of distilling between 20 and 30 lbs., and the distillates carefully fractionated in order to show where the diminution (if any) has been made by this process in the various products to be derived from the tar. The summary on next page, unfortunately, does not give a complete record for any of the series, with the exception of the Derbyshire coal, owing to the numerous accidents with the samples and want of sufficient time. It is anticipated that further figures will be presented at a later date.

A sample of about 20 to 25 lbs. of each day's tar has been distilled; the whole of the products distilling over under 130° C. being collected in one fraction, and the remainder of the distillates up to the highest temperatures attainable being collected as the second fraction.

The first portion was then further fractionated in a "Glynsky's" three-bulb fractionating tube. The fractionation was continued further, and the products boiling between 130° C. and about 200° C. were carefully separated. Naphthalene was collected separately. Above naphthalene to 300° C., the total distillates deducted from the amount taken

Distillation of Tar.

[The figures relating to the fractions are cubic centimetres per litre.]

—	Fractions.					—
	1st.	2nd.	3rd.	4th.	5th.	
	15° to 130° C.	130° to Naphthaline	Naphthalene.	Naphthalene to 300°.	Residue.	Sp. Gr. of Tar.
SERIES A. — *South Yorkshire Peas.*						
(2) Coal alone. No seal. .	12·8	20·3	60·3	18·6	888·0	1·25
(4) Water gas through hydraulic. No seal . .	4·6	7·4	18·5	3·7	965·0	1·19
(6) Water gas through retorts. No seal. . .	nil	nil	24·0	nil	976·0	*
SERIES B.—*First-Class Cannel.*						
Coal alone with seal . . .	15·1	39·3	108·2	33·5	803·9	1·190
Water gas through hydraulic. No seal	7·9	27·1	52·0	110·0	803·0	1·200
Water gas through retort. No seal	6·9	64·8	20·8	101·9	805·6	1·195
SERIES C.—*Inferior Cannel.*						
(2) Coal alone. No seal. .	28·6	66·0	46·1	119·7	739·6	..
(5) Water gas through retorts. Seal. . . .	31·7	70·9	29·5	225·5	624·0	..
SERIES D.—*Derbyshire Coal.*						
(1) Coal alone with seal . .	18·1	61·1	170·0	nil	750·8	1·220
(2) Coal alone without seal .	3·5	14·9	126·1	10·6	844·9	1·217
(3) Water gas through hydraulic. With seal .	16·4	56·1	151·9	nil	775·6	1·210
(4) Water gas through hydraulic. No seal . .	12·0	40·9	147·0	22·9	777·2	1·220
(5) Water gas through retorts. Seal. . . .	10·5	19·8	162·7	14·7	792·3	1·222
(6) Water gas through retorts. No seal. . .	12·3	21·1	129·4	19·1	818·1	1·210

* Tar very stiff, semi-solid; could not determine the specific gravity.

are designated "residue." It was found that, generally speaking, with the addition of water gas, either through the hydraulics or in the retorts, the first portion of the distillates was considerably reduced; the second was diminished somewhat; and the naphthalene in the majority of the tars nearly disappeared. On the other hand, the products coming over above naphthalene up to 300° C. increased considerably, and the remaining pitch, although shown as residue, very often contained a considerable amount of oils boiling above this temperature.

With the small experimental still, it was impossible to take the distillation any further; and it is hoped that at a future date it may be possible to distil many of these tars on a very much larger scale. With the cannel tars (Series B), it will be noticed, in the third column, that with coal alone with a seal there are 108·2 cc. of naphthalene per litre of tar. With water gas through the hydraulic and no seal, this is reduced to 52 cc.; and with water gas through the retorts with no seal, it is still further reduced to 20·8 cc. per litre. Generally speaking, with few exceptions, this is a rough indication of the composition of the whole of the tars under observation.

In the case of the South Yorkshire pea nuts (Series A), it was found that the tar formed when water gas was passed through the retorts with no seal was of such a consistency that it became utterly impossible to obtain its specific gravity by any ordinary method. This same tar, on distillation, was found to yield no distillates whatever up to 300 cc. with the exception of 24 cc. of naphthalene per litre; and although the still was heated as much as possible with the furnaces available, when the pitch was run off, it was of a plastic and "ropy" consistency. There appears to be a marked similarity between the tar formed when water gas is added and the tars made in the Mond gas process, the results of the distillation of which, compared with those of the distillation of one of the ordinary works tars, are appended in the next table. In the Mond gas tar, it will be noticed that the extent of products coming over between 200° and 360° C. is considerable.

Distillation of Tar.

—	Mond Gas Tar.	Ordinary Gas-Works Tar.
Specific gravity	1·175	1·133
Volatile matter	78·15 per cent.	68·77 per cent.
Fixed carbon	21·85 ,,	31·23 ,,
Water	9·35 ,,	2·07 ,,
15 c. to 130 c.	0·33 ,,	2·77 ,,
130 c. to 170 c.	0·14 ,,	4·93 ,,
170 c. to 195 c.	1·68 ,,	6·01 ,,
195 c. to 360 c.	31·21 ,,	25·0 ,,

Carbon.

One curious sidelight, which is worth mentioning, has been thrown on the value of self-enrichment. In No. 1 retort-house, one bed has been worked by the side of the experimental set, in order to give the men full employment. After the two sets had been at work for a few months, it was noted that the deposit of carbon in the retorts in the ordinary set was very much more marked than in the case of those in the experimental. It was therefore decided to keep the carbon from the two beds in separate heaps after each scurfing; and, at the end of about six months' working, the two heaps were carefully weighed. The average shows that in the ordinary set 149·4 lbs. of scurf has been removed per retort per month; whereas in the testing set only 38·1 lbs. per retort per month has had to be taken off. Obviously the dilution of the vapours and gases in the retorts has prevented the hydrocarbons being split up by the action of the too intense heat; and this has minimized to a very considerable extent the formation of scurf on the sides of the retorts, and that which would have been deposited has been passed forward in the shape of either tar or gas. The same process may perhaps have been carried on in the case of the tars themselves; and this possibly accounts for the small percentage of pitch, and the reduced quantity of free carbon discovered in them.

Sulphate of Ammonia.

With the addition of water gas, the sulphate of ammonia per ton decreased, with only two exceptions — viz., on April 14 with water gas through the hydraulic and no seal (Series D, No. 4), and on April 9 with water gas through the retorts and no seal (Series D, No. 6) when it reached 24½ lbs. and 26 lbs. respectively, as against the basis of 15·25 lbs. It is possible that the increase of sulphate of ammonia per ton on April 14, when 55 per cent. of water gas was added in the hydraulic main, was due to this high percentage of water gas reducing the temperature of the gas above the charge. On Feb. 1, however, when in the hydraulic main with seal (A3) was added the abnormal percentage of 65·5 per cent. of water gas, no increase whatever was recorded in the ammonia per ton, but a reduction to the almost record figure of 2·6 lbs., which is in direct contradiction to the above supposition, although with the low-grade Nottinghamshire cannel the yield of sulphate of ammonia does appear to have increased somewhat with the addition of water gas.

Illuminating Power Test.

No writer on the subject of mixed gases can ignore the question of testing for illuminating power, more particularly seeing that a standard of 10 candles has been offered by Parliament to a suburban gas undertaking during the present session. The candle power recorded throughout the whole of these experiments has been obtained by consuming the gas in a No. 1 "London" argand burner at such a rate as would give a 3½-inch to 4-inch flame, or to properly fill the chimney. It is naturally supposed that the consumer will raise or lower the gas supply until he obtains the maximum illuminating power with the smallest consumption; and this method has been adopted in all the tests, the results of which are shown in the tables attached to this paper. In most cases, the gas was submitted to a second test to show what the candle power would have been with the gas burning at the rate of 5 cubic feet per hour instead of at the more efficient rate. There is also given the height of the flame at the 5-feet rate, and the height at the rate at which the candle power was taken; so that some approximate indication could be obtained of what the air equivalent of the gas would be.

There is no doubt that the British gas industry is tardily following the steps of the more progressive German engineers on this question of candle power; and admitting that the future development of the gas industry may possibly be on the lines of lower illuminating power, one cannot overlook the unreasonable suggestions of the London County Council on the testing of all gases at the standard rate of 5 cubic feet per hour. In testing some of the low-grade mixed gases at the 5-feet rate, a result of about 8 candles was recorded; whereas when testing the same gas at such

a rate as to properly fill the chimney, or, in other words, using the burner in the manner for which it was designed, an illuminating power of 12 to 13 candles was obtained, or, approximately, 50 per cent. higher. This clearly shows how great an injustice would have been done to the gas industry at large if the South Metropolitan Company had consented to adopt such an unfair method of testing for illuminating power as was offered to them; and Sir George Livesey, who has already done such yeoman service, has placed the whole industry under a still further obligation to him by the generous and self-sacrificing manner in which he has undertaken to fight its battles on this question.

Cost of Production.

The writer thinks that his experiments prove that it is possible, by diluting the coal gas with water gas, and thereby reducing the illuminating power, to increase the total bulk of gas obtained per ton of coal; but if it is impossible to show that the gas manufacturer can so reduce the cost of production of the mixed gases as to give the consumer more heat for the same money, the process certainly cannot

Example of Tests for Illuminating Power from April 7 to 18, 1905.

Date 1905.	High Rate.			5-Feet Rate.		
	Rate.	Illuminating Power.	Flame Length.	Rate.	Illuminating Power.	Flame Length.
	Cubic Feet.	Candles.	Inches.	Cubic Feet.	Candles.	Inches.
April 7	6·50	12·66	3·0	5·05	9·58	1·8
,, 7	6·20	12·22				
,, 8	6·20	12·74	3.2	4·95	9·35	1·6
,, 8	6·50	13·74				
,, 9	6·60	11·21	3·5	5·10	7·23	1·5
,, 9	6·85	11·92				
,, 10	7·30	10·54	3·0	4·90	4·75	1·5
,, 10	7·30	11·11				
,, 11	6·90	12·60	3·5	4·90	9·00	1·8
,, 11	7·10	12·62				
,, 12	6·90	11·97	3·3	4·90	8·25	1·5
,, 12	6·75	11·93				
,, 13	6·30	13·24	3·0	5·00	10·46	1·8
,, 13	6·30	13·85				
,, 14	6·75	10·55	2·8	4·95	6·71	1·7
,, 14	6·90	11·12				
,, 17	6·20	14·53	3·5	4·90	11·58	2·0
,, 17	6·20	14·69				
,, 18	5·75	16·49	3·6	5·00	15·78	2·5
,, 18	5·45	16·69				

be said to be an economical success. To some extent, he agrees with the statement of Mr. A. G. Glasgow, that gas *per se* must be looked upon solely as a vehicle for carrying either heat or light to the consumer; and now that incandescent mantles are almost universally adopted, and consequently not less than 70 per cent. of the coal-gas supply is used because of its calorific value, the question of illuminating power can to a very great extent be ignored. In estimating the value of these mixed gases to the consumer, the percentage of loss in heating value must be deducted from the selling price, and the saving in the works cost of manufacture must amount to an equal or even greater sum than this diminution in value.

At Nottingham, the works costs amount to 12·06d. per 1000 feet. The selling price is 30d. If, therefore, in supplying mixed gases, the heating value is reduced by 10 per cent., 10 per cent. on the cost price to the consumer, or 3d. per 1000 feet, must be saved in the manufacturing costs. It will be seen that 3d., or 10 per cent., on the consumers' buying price is equivalent to 25 per cent. on the works costs. To estimate loss or gain, some figure must be accepted as a basis of calorific value; and for the purposes of this paper only, the writer accepts Mr. Glasgow's very high figure of 550 B.T.U. net calorific as the average heating value of the normal gas supply, which is very much higher than that of practically the whole of the London and Suburban Gas Companies. For several days this exacting figure was obtained in the course of the Nottingham experiments.

The estimated cost of manufacturing blue water gas at Nottingham is about 2½d. per 1000 feet; and taking as an example the results for Feb. 1, when 65·5 per cent. of blue water gas was added, then

1000 cubic feet of coal gas at	12·060
650 ,, ,, of water gas at 2½d. per 1000 . .	1·625d.
1650	13·685d.

Or 1000 cubic feet of mixed gases cost 8·29d. Then as the normal standard of 550 B.T.U. is to the net B.T.U. with this admixture—namely, 488—so the Nottingham selling price of 30d. per 1000 must be to the new figure at which this mixed gas should be charged to the consumer.

550 : 488 : : 30d. : the selling price.

This gives a new selling price of 26·6d. per 1000 cubic feet, or a reduction of 3·4d. per 1000 feet. But the department has gained the difference between 12·06d. and 8·29d., or 3·77d.—thus showing a net gain on the transaction of 0·37d. per 1000 feet. In addition to this actual money gain, there is the very great benefit of the many substantial and very real collateral advantages.

Application to Incandescent Lighting.

Provided that these low-grade mixed gases are cheaper than the ordinary rich coal gas, both to the manufacturer and the consumer, it is obvious that, in order to maintain a satisfactory supply, the gases must be suitable for all the purposes for which ordinary coal gas can be used.

The author has found, from tests made in a burner specially constructed for the work, that blue water gas can be used in incandescent burners with even more satisfactory results than can be obtained with ordinary coal gas. In these experiments (see table appended), an ordinary 32-hole argand burner was fitted with a 12-inch by 1¾-inch glass chimney and an ordinary "C" mantle, with the result that, when consuming water gas at the rate of 9·42 cubic feet per hour, 110-candle power was obtained from the burner, or 11·67-candle power per cubic foot.

Incandescent Burner Tests, using Coal Gas and Water Gas.

—	Water Gas.	Coal Gas.
Actual light, candles . . .	110·00	93·00
Gas consumption per hour, cubic feet	9·80	6·15
Do., corrected to N.T.P. . .	9·42	5·91
Candles per foot	11·67	15·74
Calorific power, gross and net, B.T.U.	325—300	622—559
B.T.U. per candle (gross figures)	27·80	39·50
Efficiency	1·42	1·00
Burner	Argand burner, 32 holes.	Bray's burner with adjustable gas and air supply.
Mantle	Veritas "C."	Veritas "C."

The photometer used was the ordinary Letheby open bar, and the gas was tested against a 10-candle power pentane table photometer standard burner. On the same photometer, with the same standard burner, an ordinary Bray incandescent burner with adjustable gas and air supply was afterwards tested with coal gas, using the same mantle and adjusting the coal gas to give the maximum light; the result being 93-candle power, with a consumption of 5·91 cubic feet of gas per hour, or 15·74 candles per foot. The calorific power of the water gas and coal gas was 325 B.T.U. gross and 300 net, and 622 gross and 555 net respectively. The B.T.U. per candle on the gross figure was, therefore, 27·8 with the water gas, and 39·5 with the coal gas; giving an efficiency of 1·42 with the water gas, taking coal gas as unity. There is no doubt that the blue water gas works very satisfactorily indeed with incandescent mantles, provided that care is exercised in selecting a mantle to exactly fit the flame.

Tests were also made with blue water gas in inverted incandescent burners; a series of readings being first taken with ordinary 16-candle power coal gas of about 560 B.T.U. net, so as to obtain from the gas the maximum efficiency with the mantle. The candle power and B.T.U. were carefully recorded.

Blue water gas was then passed through the same burner after adjusting the nipple and the air supply; and, strange to say, the test showed that the candles per B.T.U. were exactly the same within 1 B.T.U. per candle for either blue water gas or undiluted coal gas.

It is a well-known fact that the flame temperature of water gas is considerably higher than the flame temperature of coal gas; and no doubt, with properly selected burners and mantles, this condition can be taken advantage of. To prove that blue water gas could be satisfactorily used for ordinary lighting purposes, for some considerable time past the laboratory at Nottingham has been lighted by this gas only, using incandescent burners.

Application to Gas-Fires and Radiators, and Cooking Stoves.

With regard to the use of blue water gas or low-grade mixed gases in gas fires and radiators, it is to be supposed that the efficiency of this apparatus is affected more by the flame temperature, and, consequently, the degree of incandescence of the fuel, than by the total quantity of heat in the gas consumed, and therefore blue water gas, or even low-grade mixed gases, should be considerably more efficient for application to these purposes. With regard to gas cooking-stoves, it may be taken for granted that equal efficiency will be recorded with either coal gas or low-grade mixed gases; and, from practical experience, the writer finds that blue water gas is equally satisfactory in gas-fires and gas-cookers when the air supplies have simply been closed.

Application to Power Purposes.

For power purposes, blue water gas has been found to work perfectly satisfactorily in gas-engines at the largest works. At Nottingham, one engine, about 40-horse power, which is in constant use for driving the fitters' and joiners' shops, &c., has been operated by blue water gas for several months past, and has almost paid for itself by the saving in the cost of the gas consumed. A test, extending over a considerable period, was made by running at constant speed, but not at work, the whole of the machinery, which includes three lathes, two drilling machines, punching machine, shearing machine, circular saw, mortar mill, &c., and carefully recording the gas consumed, whether coal gas or water gas. The calorific power of the coal gas and water gas in each case was tested near the site, with the result that the efficiency of the water gas worked out to 1·19 per cent., taking coal gas as unity. The following table gives the results in detail:—

Gas-Engine in Joiners' Shop, working with Water Gas and Coal Gas.

—	Water Gas.	Coal Gas.
Gas per hour, cubic feet	800	500
Revolutions per minute	192	192
Cycles	96	96
Explosions	90	55
Calorific power of gas	325-300	627-570
B.T.U. used per hour	240,000	285,000
Efficiency	1·19	1

Note.—Load perfectly constant in both trials.

At the works of the Railway and General Engineering Company, Nottingham, there is at work a 1000 horse power Mond gas plant. The Manager of the Company, Mr. L. Crosta, kindly allowed the author to take tests with one of the 80-horse power gas-engines, when using coal gas and Mond gas. The results are given in the appended table.

Tests of 80-Horse Power Gas-Engine at the Railway and General Engineering Company's Works, Nottingham.

[Engine working a dynamo, supplying power for motors, electric hammer, blowers, and travelling crane in moulding shops. The horse power generated was measured through a watt-hour meter.]

—	Mond Gas, April 20, 1905.	Coal Gas, April 12, 1905.
Gas used per hour, cubic feet	2,560	600
Kilowatts generated per hour	28	36
B.H.P. ,, ,,	37	35
Cubic feet of gas per horse power per hour	69·2	17·1
Revolutions of fly-wheel per minute	162	174
Cycles per minute	81	87
Explosions per minute	78	54
Calorific power of gas (in B.T.U.)	153 gross 131 net	600 gross 539 net
Analysis of gas—	Per Cent.	Per Cent.
Carbon dioxide (CO_2)	14·2	2·4
Carbon monoxide (CO)	14·0	8·1
Hydrogen (H)	15·2	,,
Hydrocarbons	nil	4·6
Methane (CH_4)	5·7	,,
Oxygen (O)	trace	0·9
Nitrogen (N)	50·9	H, CH_4 & N, 84·0

The engine was admirably fitted for these experiments, having a duplicate set of valves and gas-inlets for either Mond or coal gas. A full-size station meter was fitted to the Mond gas-inlet; the coal gas being measured by the ordinary meters on rent from the Corporation. The gas-engine was used for driving by a belt a dynamo for supplying power to the works. A watt-hour meter was fitted on the leads from the dynamo to the switch-board; and careful tests were made of the efficiency of the coal gas and the water gas, recording at the same time the calorific value of the gases used.

After examining the above figures, it is found that the relative efficiency of the Mond Gas per B.T.U., as compared with coal gas, is greater by 0·17 per cent.

Conclusion.

Under modern conditions, if a satisfactory supply is to be maintained when carbonizing rich coals and cannels, dilution by some means or other is absolutely necessary; and although the author holds no brief whatever for blue water gas, he is convinced that it provides by far the most satisfactory method of bringing rich coal and cannel gas into line with modern requirements. As previously stated, his object in undertaking the tests was to put the position of blue water gas, with regard to its use in carbonizing, on a well recognized footing. In order that the accuracy and reliability of such tests should be above the slightest suspicion, he cordially endorsed the suggestion of Mr. Copp, of West Bromwich, at the last Midland Association meeting, that an Investigation Committee should be appointed to thoroughly inquire into controversial subjects, such as the advantages and disadvantages of adopting blue or carburetted water gas, and for the consideration of questions of a similar nature.

Shortly after the meeting, the Committee of the Association did the author the honour of accepting an invitation, conveyed to them through the Hon. Secretary, Mr. Meiklejohn, to visit the Basford Gas-Works. The members spent the day at the laboratory, when the whole of the experimental plant, and all the recorded facts and figures, were at their disposal. They appeared to be fully convinced that every precaution had been taken to obtain reliable figures; and the author feels grateful for the opportunity he had for receiving their kindly observations and criticism. He also had the privilege of submitting the whole of the results to Sir George Livesey, who, with his customary generosity, kindly allowed Mr. A. F. Browne, of the South Metropolitan Company's Vauxhall station, to spend three days at the Basford Works, with the object of carefully investigating the whole matter. The plant during this period was entirely at the command of Mr. Browne; and every facility was given him for observing the methods adopted for obtaining the results recorded.

In conclusion, the writer feels that an apology is due to the Institution for presenting a paper of such inordinate length; but the subject is one which will not allow of very much abridgement. Even as it is, many matters could be only lightly touched upon, and others of very great interest have been entirely omitted. The whole of the results are here submitted; neither the good nor the bad, the favourable nor the unfavourable, have been omitted.

It will be obvious that an immense amount of time and trouble have been expended on the preparation of the paper; and the author has to express his great appreciation and thanks for the very able and painstaking labour of those who have helped him at Nottingham. He would mention in particular the names of Mr. F. V. Barnes, and Messrs. F. Broadhead, H. A. C. Chester, and H. Talbot.

Discussion.

Mr. A. F. Browne (Vauxhall), on being requested to open the discussion, said the reason for calling upon him was apparent from the concluding remarks in the paper, wherein the author gracefully alluded to the fact that Sir George Livesey instructed him (the speaker) to investigate the process. He went to Nottingham with sanguine anticipations, and returned a wiser man, because Mr. Brown had taught him something; but he was also rather disappointed. The magnitude of the task which devolved upon him was apparent; and the author must pardon him for reminding him that it was not three days but two which he was able to spend at Basford. Under these circumstances, it must be understood that he could only hope to bring away impressions; and it was very necessary that he should verify their correctness before reporting to Sir George Livesey. Mr. Brown had kindly sent on to him certain figures, and answered some questions put to him; and in the course of time he prepared his report. In it he said that, although

undoubtedly some measure of success had been attained—in that Mr. Brown was able to add to his gas from 25 to 30 per cent. of blue water gas, and produce mixed gas quite sufficiently good for the all-round purposes of the consumer—nevertheless the result was distinctly disappointing, in view of the anticipations which they had been led to form of the process. A copy of his report was sent to Mr. Brown; and it gave him great pleasure to find that, although he did not agree with him throughout, there was not a very great difference between them on the more important facts of the results of the experiments. He came away from Nottingham with the highest respect for Mr. Brown as an investigator and as a scientific observer, and had much pleasure in stating that every facility was given him to overhaul and examine all the plant in any way he pleased, and to investigate all the records. Either Mr. Brown himself or his assistants, with several of whom he came into contact, appeared only too willing to give him the fullest information. So far as he was able to judge, this series of elaborate experiments must be accepted as *bonâ fide*, and without the slightest shadow of suspicion attaching to them. What Mr. Brown had put down in his tables were the results he had actually found. Every experiment were recorded; and, so far as he could hear, none were excluded because in some way or another they differed widely from the general average. He congratulated Mr. Brown on having achieved a great experimental success. He told them that in such complicated processes he had been able to obtain results which he could repeat at will; and that was perhaps the first occasion on which such a statement could have been made with regard to their involved retort processes. But had he done any more? Had the process in his hands achieved a commercial success? Opinions would differ on this question; and he was afraid that, much as he should have liked, he should be unable to conceal his own. The figures were necessarily formidable, from the length and scope of the experiments; but the smaller tables A, B, C, and D, admirably summarized the chief results. The lowest terms of the experiments would be found in these four tables. He had ventured on this occasion to make an innovation on the usual practice, because, so far as he knew, in no discussion as yet had a speaker ever ventured to prepare tables of his own in illustration of the paper he was called upon to discuss. In fact, it seemed to him so great an innovation that he did not like to do it without the permission of Mr. Brown and the President. But he had secured this permission, and had furnished Mr. Brown with copies of the tables. He proposed to refer first of all to the gas made per ton of coal, as to which he had told Sir George Livesey that there was no undoubted gain. If they would turn to Table A, and run their eye along the line showing the make of gas per ton, they would find in columns 1 and 2 the results of experiments with coal only; and that was Mr. Brown's basis. He had ascertained that in the most careful manner before proceeding to find the effect of the use of the process. He was justified, therefore, in taking Mr. Brown's best result with coal only as 100. Then the other figures would be seen in their true ratio. The results appeared in the first of the following tables.

Gas Made per Ton of Coal.

[A = South Yorkshire, B = First-Class Cannel, C = Local Cannel, and D = Derbyshire.

—	1*	2	3	4	5	6	Highest Gain. Per Cent.	Greatest Loss. Per Cent.
A	98·00	100·00	102·07	100·32	91·32	98·71	2·07 (3)	8·68 (5)
B	96·71	100·00	95·91	100·13	98·09	93·99	0·13 (4)	6·01 (6)
C	100·00†	..	97·38	..	98·34	..	Nil.	2·62 (3)
			3A					
			97·85					
D	89·25	100·00	87·63	88·88	87·32	97·18	Nil.	12·68 (5)

Heat Units—Coal Gas alone.

A	100·00	96·83	101·72	101·44	97·26	97·69	1·72 (3)	2·74 (5)
B	98·68	100·00	103·15	96·45	101·97	98·28	3·15 (3)	3·55 (4)
C	100·00	..	101·29	..	99·67	..	1·29 (3)	0·33 (5)
			3A					
			100·49					
D	97·58	100·00	103·48	102·57	97·73	103·48	3·48 (3 & 6)	2·27 (5)

Hydrocarbons per Ton—Cubic Feet.

A	91·14	100·00	114·00	125·43	92·57	127·71	27·71 (6)	7·43 (5)
B	81·16	100·00	90·99	105·49	99·58	105·90	5·90 (6)	9·01 (3)
C	100·00	..	116·55	..	112·53	..	16·55 (3)	Nil.
			3A					
			107·01					
D	90·09	100·00	106·60	96·31	108·29	92·16	8·29 (5)	7·84 (6)

Candle-Feet.

A	100·00	91·94	113·29	99·79	107·30	111·92	13·29 (3)	0·21 (4)
B	94·69	100·00	100·80	113·99	103·37	116·29	16·29 (6)	Nil.
C	100·00	..	123·46	..	113·85	..	23·46 (3)	Nil.
			3A					
			110·01					
D	100·00	96·79	106·72	108·11	105·77	102·66	8·11 (4)	Nil.

Tar—Gallons per Ton.

A	100·00	90·06	105·96	100·99	105·09	92·05	5·96 (3)	7·95 (6)
B	100·00	96·00	128·00	100·00	128·00	92·00	28·00 (3 & 5)	8·00 (6)
C	100·00	..	71·74	..	86·52	..	Nil.	28·26 (3)
			3A					
			89·13					
D	100·00	96·55	94·21	94·21	100·00	106·89	6·89 (6)	5·79 (3 & 4)

* The numbers heading the columns are identical with those in Tables A, B, C, and D in the paper.

† 100 = best result with coal alone.

It would be seen that the highest gain in volume was just over 2 per cent.; while losses varying from (say) $2\frac{1}{2}$ to $12\frac{3}{4}$ per cent. were recorded. Passing next to heat units, he had reported that there was no appreciable gain. Mr. Brown did not quite agree with this. He thought the gain was appreciable; and he (the speaker) found that Mr. Brown was right in some cases. The highest gain was 3·48 per cent., and the greatest loss was 3·55 per cent., as appeared from the second table. He should be the last to say that a gain of $3\frac{1}{2}$ per cent. in energy was a thing to be looked upon with contempt. They could hardly expect they would ever get such an epoch-making change in their methods that even so small a quantity would be valueless. It was worth having when one got it. But it was necessary to first catch the hare before one could put it into the gas-stove; and it seemed to him that when there was apparently no chance of getting more than $3\frac{1}{2}$ per cent. with a risk of loss approaching to something like that, they gained little or nothing in heat units by the Lewes process as experimented upon by Mr. Brown. He had next prepared a table so as to show the hydrocarbons per ton of coal; and there was at any rate an undoubted gain of hydrocarbons observable by the process. The fourth table related to candle-feet. He preferred taking it in this way rather than in pounds of sperm. It was the most modern, and lent itself better to comparison. He looked with great suspicion upon the candle-feet in these experiments. Candle-feet were the result of the multiplication of the number of feet per ton into the illuminating power, divided by 5. In this case, he thought it was misleading. On this point Mr. Brown and he developed a little friendly difference of opinion; and, after a time, he came to the conclusion that he had attached an exaggerated importance to his view of the matter. He had, however, again come to the belief that he was really right. To explain what he meant, he might say that Professor Lewes, in one of his Cantor Lectures at the Society of Arts in December, 1902, referred to an experiment to this effect: He took 100 cubic feet of $17\frac{3}{4}$-candle gas, and added to it 40 per cent. of blue water gas; making a mixture of about 30 per cent. The value of this in candles tested with a full flame was 14. It worked out as a gain of 11 per cent. in candle-feet, without adding any enriching material whatever. By the mere addition of blue water gas he obtained an increase of more than 11 per cent. in candle-feet. Now, what was the highest result in candle-feet that Mr. Brown had obtained? In some cases more than twice that. But 11 per cent. was a large proportion of what he actually had got; and the process must not be credited with the whole of the apparent gain in candle-feet. He would also draw attention to another statement made by Professor Lewes in 1901 at Glasgow. He said an idea had in some strange way arisen that water gas, when mixed with coal gas, rendered it less fit for use with incandescent mantles. This, however, was a total fallacy, and only meant that intelligence

had not been applied to the burner. With pure water gas, consumed in an argand burner, it was possible to develop the same amount of light from an incandescent mantle as was obtained from the same mantle on an atmospheric coal-gas burner of the usual type, consuming a mixture of coal gas and air; the reason being that, as the water gas gave a non-luminous flame, no previous admixture of air was necessary—the gas burning where it came in contact with the atmosphere, and the whole of the heat units being utilized to raise the mantle to incandescence. So that, though the calorific value of the coal gas might be double that of the water gas, there was practically little or no difference in the temperature of the outer zones of the flames in which the mantle was heated. He proved by the experiment that the result, when there was an adequate adjustment of the air supply, worked out at 20·5 candles with the mantle with coal gas only, and at 20·1 candles with the mixture; the rate of consumption in both cases being 4 cubic feet per hour. It was clear, therefore, Professor Lewes said, that, if care were only taken to properly adjust the burner, the air supply, and the mantle, the differences due to the lowering of the candle and calorific values of the gas became so small as to be negligible. The next question was that of tar. Mr. Brown had rightly made a great point of the importance of the modification he had effected in the volume of tar produced. The results appeared in the last of the tables. It was true that in some cases he gained largely; but in others he lost considerably. Mr. Brown was a specialist in tar distillation; and if there was any man in the three kingdoms who knew where to place his tar products, he believed that it was Mr. Brown. Tar distillation was like mother's milk to him. He had been brought up on it; and if he could secure, by this or by any other process, 25 per cent. increase in his tar products, so much the better for the Gas Department at Nottingham. No doubt he would manage to dispose of it at a profit. But supposing they were all doing it, what would be the result? He might refer to what the President himself had said in his able address, where he pointed out that, as a matter of fact, the value of tar to the gas maker had declined during the last twenty years. He himself knew nothing about tar distillation, and was no authority upon it; but he had made some inquiries, and was told that an increase of 25 per cent. in the production of tar would be a very serious thing for the gas industry. They would not know what to do with it, and very shortly they would be burning it again, as some of them remembered doing. He would now proceed to another success of the process, which was of real importance—namely, the effect on the reactions occurring in the retort after the gas was evolved, due to the influence of radiant heat on the liberated gases. They all knew the result which followed—viz., the dissociation of the gas. That this had been greatly checked, if not entirely prevented, was undoubtedly proved by these experiments; and it was a great triumph. Mr. Brown had found that the benzol, toluol, and xylenes, though they were more in the gas, were less in the tar and gas together with the process than without it. He put more into his gas where he wished to have it; but he had less altogether. This fact seemed to point to a reduction of retort temperature by the process, in consequence of which the volume of these high-temperature products was reduced. Mr. Brown got another proof of this in the absence of a large quantity of free carbon in his tar, which showed that there had not been so great dissociation of the benzol and other kindred products with liberation of hydrogen. This was a very important matter indeed, on which he congratulated the author most sincerely. It was strange, but true, that in an article contributed by Mr. W. Young to the "JOURNAL OF GAS LIGHTING," referring to what might be expected to follow the introduction of blue water gas into the coal-gas retort, he made what, in the light of Mr. Brown's experiments, read like a prophecy. Mr. Young—that great master of retort processes—had not assumed the *rôle* of a prophet, as so wise a man never prophesied unless he knew; but if there was one man who knew what went on in a retort—because he had been there, and had tried these things—it was Mr. Young. What was it he said? He said that if blue water gas were introduced into the retort, they would avoid the dissociation of these products, which no doubt would be a gain in itself, but they would run the risk of loss of volume. Mr. Young told them that if their object was to add a greater rather than a less volume of blue water gas to their coal gas, they might get all they wanted, so far as enrichment was concerned, outside the retort-house, and run no risk of loss of volume. In that case, however, they would lose the great advantages of the avoidance of dissociation in the retort and the diminished production of naphthalene. The latter was a point which came home to himself; and, though he did not wish to mention this subject, he might take the opportunity of saying that he believed some of them did not know what naphthalene was. So far as the commercial aspect of the subject was concerned, they could get all the benefit of the addition of these products to the gas without going to the expense, trouble, and risk of altering all the plant to obtain these problematical results by passing the gas through the hydraulic main or the retorts, simply by the ordinary benzolizing process, or by running it over and through warm tar in suitable vessels. There was nothing they need be afraid of robbing the water gas of; it would take up all these products. Nevertheless, Mr. Brown had achieved the great success of showing the direction in which it was possible to work to prevent these deleterious things occurring in the retorts. The main point at present, however, was the commercial aspect of the question. He sympathized with Mr. Brown's zeal for discovery. He was a pioneer, and they could not have too many of such men. He was doing good and great work, which would redound to his credit as a capable engineer. But what they were concerned with was the commercial aspect of the matter. They wanted cheaper gas and more of it; and the question was whether they were going to get it by the means proposed. He was afraid that, on the whole, they would think his summing-up of the process was not favourable to it. Certainly, if it was to stand or fall by Mr. Brown's experiments, it seemed to him that the process did not quite stand where it did. He hoped that Professor Lewes was present, because he had found better results; but the Nottingham experiments had been on an unprecedented scale, and it would be a long time before they found a man willing to follow Mr. Brown to such an extent, and prove him wrong. Therefore he (the speaker) feared that for some time to come these experiments would be taken as the standard. This, in fact, was what Mr. Brown was aiming at; and if he attained his object, he had secured his reward. He was a man of great mental detachment. He would not be any worse friend of his because he had ventured to criticize him freely in this matter. He should like to say, with regard to the price of gas, that he was sorry to see what Mr. Brown proposed to do, and the line he proposed to take. What he was doing at Nottingham did not stand or fall with the success or failure of the process; he was all right in either case. Nottingham was not the best centre for coke. It did not make the best coke; and if Mr. Brown were able by the process to make a large quantity of his inferior coke into gas, and enrich it in any way he pleased—say, by simply vaporizing his extracted benzol—he could undoubtedly produce a profit. His policy was the absolutely right one. But he (Mr. Browne) was a little startled at what he had told them about the way in which he calculated the reduction in price he ought to make. This was such delicate ground that he did not dare to pursue it further—he did not know how far it was the policy of the Nottingham Corporation—and so he would confine himself to saying that it was both unnecessary and impracticable. Mr. Brown had shown that the efficiency of blue water gas used for lighting an incandescent mantle was 1·4 as compared to 1 for coal gas. They could get the same number of candles out of a mantle with less expenditure of heat units. It was not a question of calorific value, but mainly, as they were shown the previous day, one of flame temperature. Though marsh gas had a calorific value of 919 B.T.U., three times that of carbon monoxide, nevertheless its flame temperature was 4430° Fahr.; and carbon monoxide, with only 330 B.T.U., was 5530° Fahr. If they were going to add to their coal gas a mixture of blue water gas, which would give the mantle user a gas which, volume for volume, would produce as good or a better result, why reduce the price at all? And if, for strategic or other reasons, they thought it necessary to reduce the price somewhat, there was no need of a rule-of-three agreement. He did not suppose such an agreement was going to be published in the local papers at Nottingham; but he hoped it would not get abroad that the consumer was entitled to a *pro ratâ* reduction in his gas, if he was really getting as good or better gas for his purpose. If they must reduce the price, let them reduce it to a reasonable extent, but keep something in hand for the consumer

they were all so anxious about. This was what really lay at the bottom of it. It was not the mantle consumer or the flat-flame consumer, but the power consumer. They should keep something in hand, and give it to the power consumer in any way that was legitimate. Even the greatest purist in commercial matters would agree with this. He would also say that it was impracticable to make this *pro ratâ* reduction. Mr. Brown could do this without loss up to 40 per cent. in the mixture; and the figures quoted were with that mixture. He did not know how far they would ultimately go in the addition of reducers of this kind, with a good calorific value of their own, to coal gas; but, on Mr. Brown's own showing, when he got over 50 per cent. he incurred an enormous and increasing loss. Therefore it was impossible to carry to its logical conclusion the proposal to charge the consumer *pro ratâ*. Finally, what Mr. Brown's paper had done was, it seemed to him, to make out a very strong case for the addition of straight blue water gas to coal gas; and this was what he believed might be coming in the near future. He congratulated Mr. Brown very heartily on the very excellent contribution he had made to their proceedings. If he only knew the complimentary things about the paper which had reached his (the speaker's) ears, he would surely blush; but he would spare his feelings. He sympathized very sincerely with him in being prevented, owing to lack of time, from reading the paper at length. There was nothing more difficult than to curtail and pick out the salient points of a paper like the one before them; and he congratulated Mr. Brown on the way he had done it.

The PRESIDENT said he could not refrain from expressing his warm admiration and thanks for the able and candid review of the paper which they had just had from Mr. A. F. Browne. He trusted the very high standard of discussion which had been set that morning would be continued throughout the day.

Dr. HAROLD G. COLMAN (London) said he must in the first instance associate himself with the previous speaker in expressing his great gratitude to the author for his paper, and not merely for his paper, but for the way in which he had published the whole of the tests he had made in connection with this large-scale experiment, and had put them all before the members for criticism. The result could only be for good, and for the discovery of truth, which they all desired. He might omit a great deal of what he otherwise would have said, because for the most part he fully agreed with the remarks of the last speaker—in fact, he had worked out some of the tables, and had obtained figures identical with those already given. Of course, the immense mass of figures made it extremely difficult to discuss the paper at comparatively short notice. He had spent a good many hours in trying to get the general run of the figures into his head; but he had found it impossible, and should continue to study them. He could almost wish the discussion could be postponed till next year, when they would be better able to deal with the subject. Perhaps, however, his next remark would appear rather inconsistent with this, because when he looked through the figures he wished there were more of them—in other words, that some others had been furnished, without which he could not get the explanation of what were already presented. Mr. Brown had already referred to the fact that he was not able to give a complete analysis of the gas, including the percentage of marsh gas, hydrogen, and nitrogen; and he (Dr. Colman) fully sympathized with him, and understood the impossibility of doing it in the time at his disposal. In order to get a really reliable result, such an analysis required a full day for each sample; and even then they were not always too reliable, especially in regard to the percentage of nitrogen. But he thought it would be well in future if he could arrange to make a daily test for the percentage of nitrogen actually contained, by taking a known quantity, burning it with copper oxide, and collecting the nitrogen formed. He said this for a reason to which he would return later. Further, he should very much like to have seen a sufficient number of tests to enable them to make a balance-sheet between a ton of coal put into the plant in the first instance in the various tests and the total weight of products, so as to enable some kind of automatic check to be given, to see that the balance of the products obtained and the original coal taken came out fairly well. He would confine himself now to the first three tests in Table A, of which he had gone into the figures in some detail. First he would compare the two tests of coal alone, without the use of water gas, because it seemed to him that the internal evidence showed clearly that there was something they wanted to know which Mr. Brown had not yet got, and that there must in certain cases be some unknown source of error. He fully agreed with the previous speaker that all the tests had been fairly obtained, and had all been put in; but all who had made tests and had had experience of large-scale experiments, knew how difficult it was to avoid all sources of error, and how, when one thought one had done it, instead of the analysis adding up to 100, it came to (say) 92 or 108, and one could not see exactly where the error was. Taking the test of coal alone, with seal, he had calculated the weight of the gas produced from the volume of coal gas given and the specific gravity. The former was 11,704 cubic feet, and the latter 0·368, and the weight of gas came to 329·6 lbs. When done without the seal, the quantity was 11,942 cubic feet, the specific gravity 0·413, and the weight of the gas 377·5 lbs. There was an increase in the weight of the gas of 14·5 per cent.; and yet if they looked at the figures he had worked out to percentages, in spite of the additional weight the gas had a sperm value 10 per cent. lower than the lower weight of gas, and a calorific power 3 per cent. lower. This was a result manifestly impossible, if the whole of the gas was composed of combustible matter obtained from the coal. The only explanation he could see was that nitrogen (in the form of air or furnace gases) had been drawn into the coal gas when working without seal. The author stated that he did not believe this to be the case; and in order to prove this, he had taken the percentage of carbonic acid and the percentage of oxygen in the gas. Now, if he (Dr. Colman) were right, it would require the drawing in of something like 8 per cent. of nitrogen to account for the result—*i.e.*, the lowering by 10 per cent. of sperm value and 3 per cent. of calorific power. If this 8 per cent. of nitrogen had been drawn in as furnace gas, some 2 per cent. of carbonic acid would be drawn in as well—*i.e.*, only about one-fourth of the volume of nitrogen introduced. That was why he particularly regretted that there were no determinations of the actual percentage of nitrogen in the purified gas. Proceeding further to the test in which the water gas was passed into the hydraulic main, there was no question there of altering the conditions of carbonizing in the retort, as the water gas was added in the hydraulic main, the vacuum in the retort remaining the same. Therefore, under the two sets of conditions—the coal gas with seal and no water gas, and the coal gas with seal and water gas, passing into the hydraulic—the actual constitution and composition of the gas arriving in the hydraulic main through the ascension-pipe must have been the same in both cases. And yet the composition of the tar obtained when the water gas was added in the hydraulic main was not merely physically, but chemically and entirely, different. The table giving the results of the distillation of tar showed that a large difference existed. This, of course, was quite contrary to all preconceived notions. He did not want to stand upon preconceived notions, because nothing was more dangerous; but, at the same time, when all the evidence one had available was to the contrary, it naturally made one hesitate before accepting it. What it must mean was that when water gas was put into the hydraulic main at a temperature of only 140° Fahr., a chemical reaction of a very wide and far-reaching nature took place between the constituents of the water gas (carbon monoxide, hydrogen, and carbonic acid) and the tar vapours that were coming in from the retort. He knew of no evidence at present to show that in any case similar reactions had been known to take place; and until Mr. Brown could show him definitely that such reaction could occur by acting on the tar constituents at this temperature—if he could take ordinary coal tar and act on it with water gas at 140° Fahr., and then get a rearrangement of the chemical constituents and reduction of the naphthalene and an increase of the other oils—he could only take up a position of doubt upon the matter. But there was a bigger difficulty than this in the test, which he (Dr. Colman) only discovered the previous evening. He followed up the same methods which he had adopted with tests Nos. 1 and 2, and worked out the weight of the gas; allowing in the third test for the weight of the added water gas, from the figures of volume, specific gravity, and percentage of carbonic acid given by Mr. Brown. The weight of gas when using coal alone in the first test was 329·6 lbs.; but when the water gas passed through the hydraulic main it was 380·2 lbs.—an increase of 15·4 per cent. in the weight

of the gas. Now, the weight of the tar at the same time increased from 184·2 to 195·2 lbs. In the second case, the specific gravity of the tar was not given; but he might assume it was the same as with the coal gas alone—at any rate, it would not be lighter, as it appeared that the tar was too thick to take the specific gravity; but he assumed it to be the same as the other. The total weight of the tar and coal gas obtained was, when working with coal alone, 513 lbs., and with water gas 575 lbs.—an increase of 12 per cent. in the weight of the gas and tar. Now, the other points in the balance-sheet were the water coming out as virgin liquor and the impurities taken away. There were no data for these; but it was impossible to conceive any material difference in the water separating in the condensers with the tar, as it would depend upon the amount of moisture and combined oxygen in the coal, and thus would be practically the same in both cases. The amount of the impurities probably could not affect the figures more than 1 or 2 per cent. either way; so that the apparent result of adding the water gas in the hydraulic main was that 100 lbs. became 112 lbs. He thought there must be a mistake somewhere which had not been discovered. He believed Mr. Brown was very anxious that any possible source of error should be pointed out; and he was sorry to say that at present he could not see any point at which the error could come in. This fact remained to be explained. He had not had time to go through all the figures in the same way. In Table D, dealing with coal alone, with and without seal, there was again an increase in the weight of gas produced without seal to the extent of 16·7 per cent.; and simultaneously the sperm value of this weight of gas had decreased more than 11 per cent., and the calorific power only increased about 2·5 per cent. It seemed to him that the prime object of gas manufacturers was to obtain from the coal the highest percentage of its energy they were able, in the form of gas, with the proviso that the gas should contain as small a volume as possible of inert constituents. Of course, he was not referring to gas of the Mond kind, where there was 70 per cent. of inert gas. So far as he could see, on looking at the tables and working out the percentages, the net gain of gaseous energy (to use a somewhat incorrect term) on the average of these tests where water gas was added, was something under 1 per cent. —in some cases a considerable loss, and in others a considerable gain. Actually, in the table of inferior cannel the alteration in the energy content of the gas was practically *nil;* it was all within the limits of experimental error. He must again express his thanks to Mr. Brown for his paper, and his regret that he had had to criticize some of the author's results; but he knew this was the object with which the paper had been brought forward, and therefore he did not feel guilty on that account.

Mr. J. P. Leather (Burnley) said he had to thank Mr. Brown very much for bringing before the members a paper of such importance as the one before them, and having the courage to put all his results forward in such a way that they could be freely criticized. With regard to the commercial aspect of the question, Mr. A. F. Browne had dealt so fully with it that he need not dwell upon it, because he agreed with what had been said. He should hardly have risen had he not thought that he might add a few small points which Dr. Colman had not mentioned. He had not been able to devote so much time to the paper as he should have liked. He did not think he had read it more than five times; and he had not really managed to analyze the tables. He thought that it would have been desirable to get a full acquaintance with the general body of the paper before attacking these; and it was only that very morning that he had devoted any time to the large sheets of figures. Dr. Colman had really dealt with most of the points he should have touched upon; but he had brought forward some figures in which he had taken into account the specific gravity of the gases as given in the paper. Remembering, as he hoped all members would, that he fully appreciated the value of the paper, he felt that there must be something wrong with these specific gravities. It had not struck him very specially until that morning, and, of course, he might have made a mistake; but it looked to him as if the gravities were, in some cases, too low. He was very sorry there were not full analyses of the gases, though he perfectly understood why they could not be given. But if Mr. Brown could only have supplied them in a few cases, it would have been a great advantage. For instance, taking Dec. 3, the purified gas had a specific gravity of ·351, the carbonic acid was 2·8, the hydrocarbons were 3·9, and the paraffins 0·9. He did not know exactly what the author meant by these distinctions, but he presumed the 3·9 and the 0·9 ought to be added together. The oxygen was 0·7 and the carbon monoxide 6·3. Working out the weight of the constituents given, and then making some sort of very general assumption as to the remaining amount of gas, even if it were all hydrogen, it looked to him as if it would be a little heavier than ·351. He might have made some slight error; but he did not think the figures could be quite right. The same remark applied to some of the specific gravities of the water gas; they seemed to be lower than one would expect from the analysis given of the gas. The question of the net gain from the process had been very well treated by Mr. A. F. Browne. The only thing was that the net result seemed a very slight gain by the passing of water gas even through the retorts. But there was not enough to justify them in taking up the process. With regard to the tar, he came across some things which he could not accept. The apparent alteration in the character of the tar through simply putting the water gas through the hydraulic mains was very difficult to understand. In some instances, they had a reduction in naphthalene of apparently 50 per cent., and of 80 per cent. when it was put through the retorts. Mr. Brown stated in his paper that this was the general result. But in the case of Derbyshire coal, without seal, the quantity of naphthalene in the tar was 126 cubic centimetres per litre; in water gas passing through the hydraulic, without seal, 147; and in water gas going through the retorts, with no seal, 129. So that there was an actual increase of naphthalene in these two cases, though Mr. Brown said that a reduction of from 108 to 20 was the usual thing. In this particular series of tests with Derbyshire coal, so far as they went—and he supposed that they were the average of a considerable number—there was an actual increase, comparing the tests without seal in both cases, while in other cases there was no great diminution. On putting water gas into the hydraulic main to mix with the tar vapours, how could they change the character of the constituents of the tar to such an extent that the naphthalene was removed and something else put in its place? He did not quite see how this could be brought into accord with the results of other work. Before such statements could be accepted as facts, it seemed to him necessary that tests should be made in some entirely different way—perhaps, as Dr. Colman had suggested, by passing water gas over hot tar, and treating it perfectly distinctly from the process of carbonization in the retort; so that one could really test whether it was possible to produce an effect on the constituents of the tar by bringing water gas into contact with it. On the whole, he thought Mr. Brown seemed to have gone about the matter in an extremely scientific spirit; and nothing showed this more eminently than his determination not to accept a result as definite unless it could be repeated.

Mr. H. E. Copp (West Bromwich) said it was now nearly three years and a half since he had to deal with some of the problems connected with the use of blue water gas. The author of the paper had begun by stating that very little progress had been made in the use of water gas. This, of course, was true; but he must say he had satisfied himself that some progress had been made in that he had found out many things which should not be done, even if he had not found out exactly what should be done. He must first of all express his appreciation of the paper. The manner in which the particulars were given, and their completeness, did the author great credit. His opportunities for experimenting were very favourable; some of the members were much less fortunate. Speaking for himself, it would be quite impossible to make these experiments as experiments; they had to be a part of the practical working. This would probably account for many of the differences between Mr. Brown's results and his own, though there were also many points of similarity. The larger of the differences might easily be accounted for by the fact that they had to work on the practical scale, whereas the author had laid himself out to get the best experiments, and had been able to obtain the conditions he desired. Early in the paper the author said he commenced at Ilford by putting 5 per cent. of blue water gas into the hydraulic main; and he (Mr. Copp) should like to ask him whether he introduced it cold or heated. He asked this question because he found it had a very important

bearing upon the results obtained. He had made a series of experiments with blue water gas mixed with coal gas in the cold state and allowed to diffuse; and he found the loss of illuminating power, when using a standard burner similar to that shown by Mr. Carpenter on the previous day, with the air supply capable of being adjusted to suit the composition of the gases to be tested, was very nearly proportional to the extent to which the coal gas was diluted. But if the standard burner was used in the proper way—*i.e.*, at the rate of 5 cubic feet per hour, when more than about 20 per cent. of blue gas was added the gas became almost untestable, and showed hardly any illuminating power at all. With a variation in the chimney and the rate of consumption, it was not possible to get anything like reliable illuminating power results. With regard to the tar, he had found, as Mr. Brown had done, an increase in the volume; but the thickness and viscoscity made it almost valueless. Mr. Brown was in the happy position, which most of them were not, of being able to deal with his own tar to a large extent. When other people had to deal with it, if this method were adopted he felt there would be serious trouble, because when tar was thick it was almost impossible to distil it. Further than this, it was impossible to separate the water with which it was mixed. He was glad to hear Mr. A. F. Browne's remarks, because, while he did not feel quite able to put forward his own views on the matter, Mr. Browne had very nearly expressed what he would like to have said; the sum and substance of the whole thing being that there was very little advantage to be gained. He had found that the nearest approach to any distinct advantage was by not introducing the water gas at any one particular point, but where it was necessary. He might explain that in this way: He had tried putting it into the retorts, and could get about the same results as he did by mixing it at a subsequent stage. He had also tried putting the blue water gas into the foul main and down one ascension-pipe and up the other side. He then thought it necessary to be a little more methodical, and so he proceeded to analyze the tar at various points; and at the points at which the tar contained the heaviest percentage of light oils, he concluded it might be advantageous to introduce the water gas. From time to time he made analyses of the tar at the various points between the receiving main and the condensers; and at the places where he found the lightest oils he introduced the blue water gas heated to a higher temperature than the coal gas at that point, to ensure that its introduction should not throw down any of the light oil vapours which happened to be present. Further, as a general statement, he had found that better results were obtained with rich gas than with lean gas—in other words, cannel gas judiciously mixed with blue water gas he found gave considerably better results than he had been able to obtain with ordinary lean gas. When all was said and done, though these statistics were of very great value, it seemed to him that what they, who had an official gas tester to satisfy, had to consider was how much benzol they had to use or how much subsequent enrichment they had to introduce to keep on the right side. This, after all, was the most important point to be considered.

Mr. S. Glover (St. Helens) thought it might help in the discussion of the paper if he made one suggestion—namely, that the retorts used by Mr. Brown in his experiments at Nottingham were not universally suitable for the various coals he experimented with. If they realized the importance of the area of the retort in dealing with the charges and the various composition of coals put into them, they would be able to see really how some of these mysterious variations occurred. The reason why Mr. Copp had not been able to get any of these wonderful results at West Bromwich, was probably that his coals were already properly carbonized in the retorts in which they were placed. If they were to adopt this process in Glasgow, and expect any such results as Mr. Brown had mentioned from the retorts and the mode of carbonizing adcpted there, he did not think they would get anything of the sort. He thought the different results obtained by carbonizing in the same retort, the same size and the same length of charge, all these various cannels and various sorts of coal, confirmed his idea (which was supported by his experience in working the Peebles process) that the size of the retorts used at Nottingham was unsuitable for some of the coals or cannel carbonized; and the more or less tar produced was also due to the same cause.

Mr. Copp said he wished to explain, in reference to what Mr. Glover had said, that the results obtained were entirely satisfactory to him, and precisely what one would expect under the circumstances.

Mr. A. G. Glasgow (London) said he had taken considerable interest in the general subject of the paper; and, in the present and prospective condition of gas supply in the United Kingdom, he was opposed to the attempt to cheapen coal gas by diluting it with blue water gas—whether by so-called "auto-carburation" means or by admixture at other points. It seemed to him to be easily demonstrable that such an attempt was not profitable either to the consumer or to the producer of town gas; it was somebody else who got the benefit! His own position in the matter had been somewhat fully set forth in the Technical Press during the last four or five years; and it rested on the fact that he had not yet found an instance where the saving in cost of manufacture due to the admixture of blue water gas was equal to the loss to the consumer due to the corresponding depreciation in quality. When he could find an instance of greater saving in cost than loss in useful effect, he would be most happy to alter his attitude; for he was an advocate of that kind of gas, whatever its candle power, which would convey to the consumer the maximum of useful effect for the minimum of cost. Now, towards the end of the paper, the author claimed to show an instance of greater saving in cost than loss to the consumer; so, unless he could prove that Mr. Brown was wrong, he (Mr. Glasgow) must immediately effect a somersault in his own position. But, although it was summer time, he thought he could demonstrate that Mr. Brown's argument was "not worth its salt." He would here express his gratification that Mr. Brown rejected the superstition that "the consumer cares nothing for quality, but wants only 'cheap' gas," and had admitted that the consumer must always have a *pro ratâ* concession in the selling price for any reduction in the useful effect of his gas. When he first lifted his own feeble voice in favour of this axiom, it was like crying aloud in the wilderness, so deeply were some of the leaders of the profession then bitten with the fascination of "cheap" gas. This brought him to the one point on which Mr. Browne, of Vauxhall, and he appeared to come into collision. He had never listened to any discussion of a paper which combined at the same time so much charm, force, and effectiveness as was contained in Mr. A. F. Browne's speech. It was simply delightful. He wished that Mr. Browne might have continued without end; especially as at the close of his comments he drifted into a line which he (Mr. Glasgow) did not catch very clearly, but which left him in doubt whether Mr. Browne was serious, or whether, in the words of Artemus Ward, he spoke "sarcastic." It was in regard to the application of blue water gas to incandescent mantles. He understood Mr. Browne to infer from the paper that the author claimed for blue water gas an actual increase in incandescent effect of 42 per cent. (foot for foot) over what he obtained from the same volume of his coal gas.

Mr. Browne: No.

Mr. Glasgow said even Homer nodded occasionally, and this time it was apparently himself, and not Mr. Browne, who had fallen asleep. It would be seen from the paper that the author claimed to get 42 per cent. more incandescent effect per B.T.U. of his blue water gas than he obtained per B.T.U. of his coal gas.

Mr. Browne said what he meant to convey was units per candle.

Mr. Glasgow regretted that he had gathered the other meaning. But why, then, did Mr. Browne suggest that there should be an actual increase, instead of a compensating decrease, in the selling price of the gas?

Mr. Browne said he would not interrupt Mr. Glasgow now, but, if necessary, would explain afterwards.

Mr. Glasgow said the question of the practical or effective flame temperatures of gases or mixtures of gases was one they knew very little about. They could not, therefore, afford to draw definite conclusions from the present indefinite theories, and without further question accept practical comparisons because they apparently supported such conclusions. The calculated flame temperature was the only theoretical basis they had to work upon; and this was founded on the specific heat of the various gases and products. But it was now well known that the specific heat of gases changed as their temperature changed; and, with two such interdependent variables, even the theoretical result was very indefinite. Moreover, there was the uncertain question of dissociation. But, taking the specific

heats at normal temperature, and disregarding dissociation, the simple theoretical result was that blue water gas had a flame temperature somewhat greater than that of ordinary coal gas, and somewhat less than that of carburetted water gas. If, therefore, it were claimed that blue water gas, in consequence of this higher flame temperature, gave 42 per cent. greater incandescent effect per unit of heat than ordinary coal gas, then carburetted water gas, with still higher flame temperature and double the calorific value of the blue water gas, must give a correspondingly greatly increased effect. But he thought that the flame temperatures of the three gases were sufficiently close together to make any present attempt to distinguish them theoretically likely to prove erroneous in practice; and that, with the present imperfect theoretical knowledge and imperfect practical burners, it was admissible and advisable to regard them as having practically equal flame temperatures, and to expect their incandescent effects to be practically in proportion to their calorific powers, when burned under conditions of equal efficiency. Temperature of flame was one thing, and area of flame, which meant quantity of heat, was quite another. An electric spark might have an almost infinite temperature; but it would not do much towards illuminating the area of a Welsbach mantle. There must be sufficient "flame"—*i.e.*, a sufficient volume of products of combustion—to envelop the mantle that was used; and, in that respect, the illuminating gas would yield two or three times the volume of products of combustion that the blue water gas would yield. But they need not concern themselves much further with the theoretical situation. The real question was: What could be obtained in practice? Mr. Brown determined the incandescent efficiency of his blue water gas by burning it in an argand burner at the high rate of 9·42 cubic feet per hour—thus enveloping the mantle and developing 110 candles, or 11·67 candles per cubic foot; and he compared this result with coal gas at only 15·74 candles per cubic foot. But he did not think manufacturers of coal gas would accept this unprecedentedly low valuation of the incandescent effect of their gas. Most certainly, carburetted water-gas manufacturers could not accept any such valuation. The values determined by the Gaslight and Coke Company for the recent Committee on Metropolitan Gas Testing showed that, with their normal mixture of two-thirds coal gas and one-third carburetted water gas, the incandescent effect per cubic foot was about 23 candles for 16-candle gas and about 20·5 candles for 14-candle gas. If the usual and reliable figures were substituted for Mr. Brown's valuation of 15·74 candles per cubic foot of high-grade coal gas, there would be absolutely no gain per B.T.U. in the incandescent effect of the blue water gas. On the contrary, the gas would show a loss in efficiency. The *crux* of the whole of the matter presented by Mr. Brown was contained in his conclusion as to the economical value of his so-called "auto-carburation;" and he (Mr. Glasgow) would therefore confine the remainder of his remarks to the points bearing thereon, and avoid any further survey of the experimental results, which henceforth he would accept *in toto*. Mr. Brown conceded, as everyone must do, that the consumer must have a *pro ratâ* reduction in selling price for any reduction in the useful effect of his gas; and, to determine this new selling price, he gave this simple proportion: As 550 (the calorific value of his coal gas) is to 448 (the calorific value of his mixed gas), so is 30d. (the present selling price) to the new compensating selling price. Now, why 550? Mr. Brown gave this reason: "To estimate loss or gain, some figure must be accepted as a basis of calorific value; and for the purposes of this paper only, the writer accepts Mr. Glasgow's very high figure of 550 B.T.U. net calorific as the average heating value of the normal gas supply," &c. But why should he bring in Mr. Glasgow? Going back to an earlier part of the paper, Mr. Brown stated: "Although for many years past it had been the practice of the Gas Department to make repeated tests of all coals purchased, and there existed innumerable records of such tests of every well-known gas coal in the Yorkshire, Derbyshire, and Nottinghamshire coalfields, he decided to begin anew, and *to establish fresh figures with which to compare the results obtained with the use of blue water gas. It was therefore necessary to carbonize the coals throughout each series of tests as nearly as possible under the same conditions.*" Accordingly, by tests of eleven days, Mr. Brown ascertained that the net calorific value of the coal gas used in his Series A experiments was (see Table A—Summary) 594 B.T.U. Then, taking this gas, which had a net calorific value of 594 B.T.U., he treated it in a certain way by mixing blue water gas with it; and he found the resultant calorific value to be 488 B.T.U. Mr. Brown admitted that he must make a compensating reduction to his consumer for this loss in calorific power; but, in drawing up his compensating proportion, he very curiously compensated, not for a loss of 594−488=106 B.T.U., but for an utterly inconsequential and suppositious loss of 550−488=62 B.T.U. Mr. Brown treated gas having a certain pre-determined value in a certain way, and he then compared the result with a totally different and inferior gas, and claimed that he found a certain gain! As he (Mr. Glasgow) started by saying, this question was the *crux* of the whole paper. What mattered all the rest, if, out of his own mouth, by his own experiments and logic, but with a simple and obvious correction in his compensating proportion, it was shown that Mr. Brown's method severely penalized the consumer? If they substituted Mr. Brown's actual gas for his erroneously assumed basis of 550 B.T.U., they would get the correct proportion—594 : 488 :: 30d. : the compensating selling price. This correct proportion gave a new sale price of 24·65d., not 26·6d., per 1000 cubic feet; the necessary reduction in the selling price being 5·35d., not 3·4d. The saving in cost remained the same; being the difference between 12·06d. and 8·29d., or 3·77d. Hence the corrected figures showed a *net loss* by the process of 1·59d., instead of a gain of 0·37d. per 1000 cubic feet. This comparison was based on the supposition that 100 per cent. of the output was burnt for calorific purposes; whereas Mr. Brown gave 70 per cent. as the proportion of the total supply used for its calorific value. So, taking his candle powers at the maximum luminosity, and making a double proportion in which 70 per cent. was used for calorific purposes, and 30 per cent. for direct luminosity, the net loss due to the employment of the process became 2·30d. But this was not all. Mr. Brown drew his proportion, not from the average of his period of five days, but from a single day's working; and when they substituted his average for the term of five days, as summarized in the Table A, they got—assuming that 100 per cent. was used for calorific purposes—a net loss from the process of 2·45d. With the correction allowing 30 per cent. to be used for luminous purposes, the net loss due to the process became 3·04d. per 1000 cubic feet. Nor was this all. Mr. Brown stated that he tested the gases in an argand burner at such a rate as would properly fill the chimney of a No. 1 "London" argand—which was very reasonable; but he naïvely added: "It is naturally supposed that the consumer will raise or lower the gas supply until he obtains the maximum illuminating power with the smallest consumption." As a matter of fact, the gas consumer did not use a No. 1 "London" argand, but a flat-flame burner; and, though with a certain dilution one might show only a change from 16·69 to 12·39 candles in a No. 1 argand at the most economical rate of combustion, still from the practical standpoint what would be the luminosity of the poorer gas in the ordinary flat-flame burner? In the argand burner, at the 5 cubic feet rate, Mr. Brown stated that he sometimes found only 8 candles luminosity; so when they used a flat-flame burner, where were they? He had now, he thought, in all humility, justified his jocular promise to show that Mr. Brown's economic argument was "not worth its salt." He had not questioned the author's experimental results or altered his line of argument; he had simply correctly substituted Mr. Brown's own figures into his argument. And the resultant conclusion was diametrically different from that drawn by Mr. Brown. He had accepted the experimental results *in toto;* and this went to show how much more important it was to be sure of the correct application of such experimental data than to quibble over fine points as to their accuracy. Experiment was but a means to an end; and if this end were economically unsound, the experimental results were of minor interest. He now came to something which he was, perhaps, qualified to speak upon—namely, the cost of manufacturing water gas. The author, in his economic deductions, estimated the cost of manufacturing blue water gas at 2½d. per 1000 cubic feet. Mr. Brown and he had struggled over this question in the past, and he might cite their then conclusions to point his present argument. There was, at that time, widespread publication of the claim that blue water gas at Ilford cost 3·48d., or he would call it 3½d., per 1000 cubic feet. This figure was promulgated until it began to be accepted as a basis for comparison with the

holder costs of coal gas and carburetted water gas, and was becoming generally mischievous. He ventured, therefore, to question its accuracy—or, he should perhaps have said, to demonstrate its inaccuracy. Mr. Brown replied: "The figures I gave as to the cost of manufacturing blue water gas are certainly incomplete; but surely the omissions could be supplied by any person of average intelligence." Thereupon, the intelligences of Mr. Brown and himself had endeavoured to supply these corrections, starting from the agreed basis of 4d. Their respective intelligences arrived, the one at the holder cost of 5·11d. per 1000 cubic feet of blue water gas at Ilford, and the other at 7·87d. as the probable complete holder cost. So that, in this case, it seemed that one or other or both, of their intelligences, was or were either above or below the average. His own intelligence, such as it was, led him to think that one should not publish incomplete figures under the standard heading of "manufacturing cost." He knew of no legitimate difference between "manufacturing cost" and "holder cost," and found these terms were used interchangeably. By his own peculiar line of argument, however, Mr. Brown had settled on the estimated cost of 2½d. per 1000 cubic feet of blue water gas in his mixture. But his economic deductions were worthless, on that score alone, if this cost were not the complete manufacturing cost of his water gas; and, on the other hand, if this estimated cost of 2½d. was given as the complete manufacturing cost of the water gas, the figure was absurd. As Mr. Brown's estimated cost of 5·11d. per 1000 cubic feet of blue water gas at Ilford excluded management, office, yard, and incidental expenses, and allowed only 0·5d. for wear and tear of works, and 0·16d. for oxide purification (as against lime purification at Nottingham), there seemed no sufficient warrant for a lower estimate than 5d. for the finished holder cost of the blue water gas in his Nottingham mixture. This doubling of the cost of his water gas would, of course, revolutionize the author's economic deductions, even had they been otherwise sound. Mr. Brown had on several occasions emphasized the fact that he had been careful not to submit any result that could not be repeated at will. This claim amazed him. Mr. Browne, of Vauxhall, had given a clean-cut statement of efficiencies which appeared to bear upon this point; and he would analyze briefly the variations in the particular term of experiments with which he had himself been dealing. The average sperm efficiency for the five days of the term with which he had dealt worked out, according to Table A (Summary), at 107 per cent., or a gain of 7 per cent.; whereas the daily variation was 38·3 per cent., or 5½ times the average sperm gain for the five days. In the same way, the calorific efficiency for the same term averaged 101·4 per cent., showing an average gain of 1·4 per cent.; while the difference between the highest and the lowest daily efficiency was 11 per cent., or eight times the average calorific gain for the five days. Therefore he found that the results were conflicting, and not such as could be repeated at will. In conclusion, he must say that the paper seemed to him the swan-song, somewhat out of tune perhaps, of the moribund process of "auto-carburation."

Mr. Browne said he just wished to explain that, as regarded his suggestion that logically there should be a rise in price, this must not be taken seriously.

Mr. T. Watson (Rushden) said he was not in a position to discuss the subject from a scientific point of view, but he wished to deal for a few moments with its commercial aspect. He might say that in starting blue water-gas plant at Rushden, at the end of 1903, they put the gas in at the back of the retorts, in the hope that some of the very beneficial effects prophesied would be obtained. But after three months' working, the very erratic results they had been able to get showed them that some alteration was absolutely necessary if the plant was to be at all a success. The connections were then changed from the back of the retorts to the outlet from the hydraulic into the foul main; and from that moment they gained more than had been lost by their previous practice. In regard to the point referred to by Mr. Copp, as to heating the gas before admixture, he found a difference of 300 cubic feet per ton by heating the blue water gas. As to the tar, he had never noticed any alteration whatever; and, what was more, as a practical proof that there could not be much, he had never had any question with his tar contractor. A few figures giving the results of working on the practical scale during the whole of 1904 would show that at least there was some benefit to be gained by the admixture of blue water gas with coal gas at that point. The average make of gas at Rushden was practically 100 millions, of which the coal gas was 77·6 per cent. and blue water gas 22·4 per cent. The benzol used per 1000 cubic feet of mixed gas was 0·063 gallon, or 0·28 gallon per 1000 cubic feet of blue water gas. The illuminating power was 15·96 candles, taking the average for the whole year. The gross calorific value was 582·6 B.T.U. The average make of coal gas per ton of coal was 11,601 cubic feet; the average make of blue water gas per ton of coke actually used was 69,227 cubic feet, or, including the coke used for standing off, 57,670 feet. But to give the gas sold per ton of coal carbonized was, after all, the real test. And this, deducting the blue water gas, averaged 10,562 cubic feet. This was the quantity for which they actually had a return in pounds, shillings, and pence. Taking the mixed gases, they sold 13,581 cubic feet per ton of coal carbonized. He might say that the coal gas sold in 1903 was at the rate of 10,026 cubic feet per ton; thus showing a gain of 536 feet per ton. These were the figures showing what they had actually done at Rushden, and for which they had actually received cash. On the face of it, it required a good deal more investigation than even Mr. Brown had given to it; but on the practical working scale the gain was there. His Directors very generously accepted his estimate of the economy in manufacturing charges, and gave the consumers the whole benefit of the reduction. This was at the beginning of 1904; and at the end of that year, when the balance-sheet was made up, the expected economy had been fully realized.

Mr. Isaac Carr (Widnes) asked what was the net cost of the mixture.

Mr. Watson said he had not brought the whole of the figures with him, as he had not intended to speak on the subject; but, as far as he could recollect, the cost was 2½d. to 3d. into the holder.

Mr. Carr said he meant the net cost of the mixture.

Mr. Watson said he had not the total manufacturing cost. He knew there was a considerable reduction on 1904 as compared with 1903.

Mr. J. H. Brown asked what was the quantity of gas sent out per day in the summer time.

Mr. Watson replied that at the present time it was about 240,000 cubic feet, and in the winter about 400,000 cubic feet, in 24 hours.

Mr. Sidney O. Stephenson (Tipton) said it was about two years since he read a paper on this subject, and first started working seriously with it. He had not since seen any reason to change the opinion he then gave; and the present elaborate paper of Mr. Brown corroborated what he had said. On Mr. Brown's invitation, he had the pleasure of going with the Committee of the Midland Association to Nottingham, where he saw the great trouble Mr. Brown had taken in carrying out his experiments; and he was quite sure that everything he had set down was absolute fact. When he (Mr. Stephenson) read his paper, he had a lot of figures demanded which he could not supply; and, judging by what he saw at Nottingham, it would have been quite impossible, in works of the size of those under his charge, burdened as they were with over-capitalization, and very heavy interest charges, to attempt to go into the subject in the way Mr. Brown had done. At works of his size, he could afford to do what he (Mr. Stephenson) could not do. Consequently, Mr. Brown had greatly benefited the industry by going into the question in the way he had done. He had now had a large experience with it; and, taking the last year, when they did not use a lot of water gas, he had a good demand for coke. Putting the times when they did not dilute with water gas against those when they did, he found a gain of about 260 cubic feet per ton of coal. The thing was certainly erratic, and one could not always get the same result. Sometimes there might be a small loss, and at other times a gain. Since he had used water gas, he had never, in any district, been troubled with naphthalene, which at one time was quite a bugbear with them at Tipton. Some criticisms that he had heard of the paper, including the averages stated by Mr. Browne, of Vauxhall, on the results of the experiments, were made in a manner which he did not think was altogether fair. He had been trying the thing in various ways, and, on an average, it did not give the best results that Mr. Brown had obtained; and, to get the advantage of the system, one must take the best results. When he (Mr. Stephenson) saw the paper, it occurred to him that Mr. Brown would be beyond the criticism of not

supplying enough figures, because he thought they were all e could give. But since hearing the discussion he had learned ifferently, and had come to the conclusion that, to give all the figures members could demand would require a paper which would last the three entire days of the meeting without anything else. The author had carried out most valuable work in following up this subject. He thought they were pretty well in agreement that there was a gain in working the process. Mr. Copp, Mr. Brown, and he (Mr. Stephenson) were all working at it; and, though they did not quite agree in small details, they did essentially. He had obtained the best result by mixing the gases in the retorts. At Nottingham, Mr. Brown seemed to find it best to mix them in the hydraulic main; and Mr. Copp said that he should prefer it to be done in the condenser. But, on the whole, the result was much the same.

Mr. S. Cutler, jun. (London), said he had to thank the President for his invitation to be present, and for the opportunity to take part in the discussion. His experience in the actual use of water gas did not entitle him to express an opinion on the subject of the very careful and elaborate paper under discussion. At the same time, he thought Mr. Brown would welcome any confirmation of the statistics he had put forward; and this confirmation or otherwise was to be had to-day in gas-works not very far off, using at times English coal. He referred to the plant recently put down at the Amsterdam Municipal Gas-Works. This was a very complete example, and afforded the information which gas engineers were very desirous of having. There were two installations—one a straight water-gas plant of 2,100,000 cubic feet per diem; and the other an ordinary carburetted water-gas plant of the same capacity. Both were working practically on the same site, using the same fuel and with the same conditions applied to each. He would venture to suggest to Mr. Brown that he should put himself in communication with the Engineer of the Municipality, and obtain from him the carefully prepared analyses and results which had been kept for the last six months, so as to enable them to arrive at a definite conclusion whether the carburetted or the straight water-gas system was the more efficient one to adopt. He might say he thought the collateral advantages of the carburetted water-gas system were unaffected by any facts Mr. Brown had brought forward in his paper.

Professor Lewes said he had hurried back from an unfortunate case which had detained him in Edinburgh, and had just arrived in time to be fascinated by Mr. Glasgow's eloquence. There were one or two words he should like to say; and, in the first place, he must congratulate Mr. Brown most thoroughly on his excellent paper. They rarely had a paper in which they were given such a mass of detail, from which they could build up and work out any amount of theories—past, present, and future. In giving a paper of this character, Mr. Brown had really performed a work which was not only of the greatest possible service to the English gas industry, but which would be of interest for many years to come. In it he had said very nearly the last word on the question of the passing of cold water gas through the retort during the process of carbonization. It might be remembered that some six or seven years ago he incautiously brought forward a process by which he thought a considerable amount of saving might be effected in the carbonization of coal. They very kindly christened it the "Lewes Process;" and since then from time to time he had had the pleasure of having brickbats, small and large, thrown at him in consequence. It was generally pointed out that the difficulties of his plan were absolutely and practically almost insurmountable; but they knew what those insurmountable difficulties were. They were very much of the character of those imagined by an intoxicated man who, after repeated contact with a lamp-post, thought he must be lost in an impenetrable forest. When he (Professor Lewes) made the suggestion in regard to the passing of water gas through the retorts during carbonization, his idea was that the water gas should be at the same temperature as the retort itself, so that no check should take place on the processes going on within the retort. They knew as well as he did that directly they began to check the temperature of a retort, they had very great variations in the products given off during the analytical and synthetical processes going on within it. What was more, when carrying out a series of experiments of the kind Mr. Brown had been making—of the kind which he had tried at Sydenham and at many other places—when they tried variations in the quantity of the gas passed through, every change in the quantity of cold water gas passed in would give a different variation in the temperature of the retort. This being so, could they wonder that the results obtained had been erratic? If in one case they cooled the retort 10°, and in another 100°, and in another perhaps 200°, how could they get anything like uniformity of results? He hoped Mr. Brown would be able at some time or other to confer a still greater benefit on the gas industry with the plant he had at his disposal, and with the trained chemists he had at work on this subject. If he could see his way to trying the effect of passing through the retorts hot instead of cold water gas, he might find the "dying swan" of that unfortunate process getting a little fresh plumage, and able once more to struggle forward into the lake of their favour. Even if he could put a small superheater near the back of the retort, so that after measuring the water gas he could again heat it up and pass it on (of course, it would not be a method which could be adopted in practical working), in order first to make a few experiments to see whether these somewhat erratic results occurred when hot gas was used the same as cold, it would be exceedingly interesting. He must say that he thought at present they all owed their grateful thanks to Mr. Brown for the trouble he had taken; and he, for one—in spite of the paper having been a little bit smirched with carburetted water-gas tar during the process of discussion—should look upon it as one of the most valuable communications ever brought before the Institution.

Mr. Brown, in reply, said he was not aware how difficult a work he had undertaken when he commenced writing his paper and carrying out the necessary experiments; but he was faced with a much greater difficulty in answering at so short a notice such pointed criticisms of it. To begin with Mr. A. F. Browne, he was sorry he had misstated the length of his visit; but he believed that he had been three days at Nottingham, if he only actually spent two days in the laboratory. He remarked that the results were disappointing, as he had anticipated greater improvements due to the introduction of blue water gas during carbonization. He (Mr. Brown) admitted that, from a certain point of view, the results were disappointing; but possibly this was due to the fact that very excellent results had been obtained when carbonizing the coal alone. It would be noticed that he had obtained an increase above their normal average, in some cases of nearly 20 per cent. in sperm value, owing to the altered methods of carbonizing. By this he meant the increase in the sectional area of the ascension-pipes, the alteration in the design of the hydraulic main, and the very fine adjustment of the seals and vacuum. He had been told that these results could only be obtained by having chemists sitting on the retort-mouthpieces. Granted that this was so, the same special conditions existed throughout the whole series of experiments; and it was necessary; for the sake of making proper comparisons, to get the best possible results in each case. He contended that if the results obtained by adding water gas were compared with the average normal results, very much greater improvement would have been shown. Mr. Browne's tables were certainly an innovation in the discussion of an Institution paper. But the paper itself was an innovation; and he had felt some hesitation in presenting such a mass of figures to any Institution meeting for discussion in one morning. Mr. Browne had prepared tables and had taken the make of gas per ton, the hydrocarbons per ton, and the heat units per ton, separated them one from the other, and drawn averages. But he (the speaker) contended that the figures could not fairly be considered in this way. They should take each day by itself, and take together the make per ton, the calorific power, the specific gravity, and the constituents of the gas; and they must be considered collectively, and not individually. With all mixed gases the ordinary tests made for illuminating power were, in his opinion, unreasonable. For proper definition, not only should the candle power be taken (at the maximum rate), but an analysis of the gas, together with its calorific power and specific gravity, should be given. It was possible to have two gases, one containing 10 per cent. and the other 20 per cent. of carbonic oxide, both being of 16-candle power when tested at the maximum rate, but giving very different results when tested at the 5 cubic feet rate. These two gases would have different flame lengths, behave very differently in incandescent burners, and have different calorific powers. The analysis of the gas was therefore daily becoming of greater importance as mixed gases came more

into use. Mr. Browne also stated that they should have obtained relatively the same results if the water gas had been added at the exhauster instead of at the hydraulic main or in the retort. After the paper was completed on the 24th of May, he carried out an experiment, adding 45·5 per cent. of water gas at the inlet of the exhauster (or 31·3 per cent. in the bulk), and he obtained a diminution of 38·9 per cent. in the candle-feet per ton; showing that really there was a great gain by adding the water gas in the retort or in the hydraulic main. There was one point which he omitted to mention in summarizing the paper, which had not received the attention it deserved. Under the head of "Carbon," he stated that the bed adjoining the experimental bed had been scurfed during the same period, and the amount of retort carbon produced was carefully collected and weighed. The experimental set had made 38 lbs. of carbon per retort per month, and the bed adjoining the experimental set, in which no water gas had been used, made about 140 lbs. of scurf during the same period. With regard to his reference to the reduction in price in proportion to the candle power, he certainly did not himself agree that the selling price should be reduced *pro ratâ* with the calorific value of the gas. The statements as to the calorific power of normal coal gas supply were simply named as a basis. He did not even agree with the statement that 550 B.T.U. should be universally adopted as the net calorific power of a normal gas supply. In different localities, each gas undertaking must do the best that it could for its consumers. But, whatever the basis decided upon, the gas supply in these respects must be maintained as constant as possible. Reference had been made to the great difficulty of dealing with coke at Nottingham. On every ton of coke made for sale they had a carriage cost alone, apart from cartage, of 4s. 6d.; and only from 1-12th to 1-15th of the total coke made was sold within a radius of ten miles of the town. So that the coke difficulty was a matter of great importance. Mr. Browne portrayed the difficulties that would arise if every gas-works adopted this process, and began selling 32 gallons of tar per ton of coal carbonized, instead of 12 gallons as at present. The plant might not be a success in every locality with all classes of coal. If the process was a success, there was no valid reason why it should not be adopted at Nottingham or anywhere else, so long as by so doing they were not acting unjustly to the industry at large. They must all do the best for themselves with their residuals. He had obtained Mr. Browne's consent to read a paragraph from some correspondence that had passed between them after his visit. A portion of his reply to Mr. Browne's criticisms read: "I have read with the greatest possible satisfaction one paragraph in which you express admiration for the fairness with which the experiments have been conducted, and for the resolute determination which you consider has been evinced to arrive at the truth and record it faithfully." This was to him ample reward for the work he had undertaken. He was not an advocate of blue water gas, carburetted water gas, or any other sort of water gas. He had endeavoured to establish a basis and to arrive at the truth and record it faithfully. If he had done this, he had succeeded in all he had set out to do. He was indebted to Mr. Browne for his candid and fair criticisms. Dr. Colman regretted that he (the speaker) was unable to carry out daily a complete gas analysis. Of course, it was impossible to do all they would like to have done. The paper had even now reached most inordinate length; and if they had developed all the side-issues which had been suggested, it would have occupied the whole of the week. He said that the increase in the weight of gas yielded per ton of coal was more than the coal was capable of; and he suggested that this was due to the drawing in of about 8 per cent. of nitrogen along with the furnace gases. He (Mr. Brown) disagreed entirely with this suggestion. The very light specific gravity of the gases proved that this could not be possible. The analysis only showed 2, 1·4, and 1·8 per cent. of carbon dioxide in the crude gas, which was a very low figure for ordinary coal gas; and he thought this fact alone completely answered Dr. Colman's contention. As to the tar, it did certainly appear that its constitution was altered when the water gas was added in the hydraulic main. He was entirely at a loss to explain the reason; he could not explain it. He had simply recorded the facts of the experiments as they occurred. He could not give an explanation, and had never attempted to do so. He brought the facts forward for discussion and criticism, in the hope that they might receive some light on this very difficult subject. Going on to Mr. Leather's criticism, he evidently also had some doubt with regard to the specific gravity of the gas. It was taken in each case with Schilling's specific gravity apparatus, and the tests were made sometimes two, three, and four times a day. They invariably came within a very small percentage of one another, though they were taken independently by different people in each case. He had taken the averages of the specific gravities, and applied them all through. They were for several days with varying quantities. Mr. Leather had taken only one day. He also spoke as to the tables giving the results of the tar distillation, and pointed out that in the case of Table D the diminution in naphthalene was not so marked. In Table A it was most marked, and also in Table B. On the last table there was still a diminution, but not to so great an extent. It dropped from 170 to 162 and 129 cubic centimetres per litre; and he well knew that when carbonizing Derbyshire coal the quantity of naphthalene varied considerably with the coals. With some, there was a large amount; and with others, very little. There appeared to be no ascertainable reasons for the variations. Mr. Leather also said he should like to know whether passing water gas through coal tar under other conditions would give anything like the same results. He thought that perhaps they would get different results. It appeared to be more reasonable to continue with exactly the same conditions, and try to discover the reasons. With regard to Mr. Copp's remarks, the water gas at Ilford was added cold; and though it appeared strange, they found that the best results were obtained when the water gas was admitted to the retorts at the lowest possible temperature. The only explanation he could suggest was that it possibly reduced the temperature of the gases above the charge, and prevented the splitting up of the hydrocarbons by the radiant heat; and this possibly accounted for the large increase in the hydrocarbons per ton of coal. He was pleased to know that Mr. Copp also confirmed his experience with reference to the increase in the quantity of tar produced, and also as to the amount of water in the tar. The percentage of water increased, roughly speaking, about 25 per cent. The daily tables also confirmed Mr. Copp's statement that the improvement was more marked with the richer than with the lean coals. He also made some references to the use of benzol; but he (Mr. Brown) might say that, throughout the whole series of experiments, no benzol whatever was used. The experimental gas was mixed with the bulk of the gas going out; and as it only represented about 100,000 to 120,000 cubic feet a day mixed with some 6,000,000, or whatever the quantity was, it was a negligible amount. He had purposely avoided the use of benzol, in order that the results should not be interfered with. He was at a loss to know how to answer Mr. Glasgow. Throughout the whole of the paper he had omitted altogether the financial aspect of the question. He looked on the experiments simply as experiments, without any consideration as to whether it was feasible to adopt the process or whether it would be a commercial success. He was tempted, he was afraid, to put in these particulars with regard to cost, calorific power, and price, in order that he might have the pleasure of hearing Mr. Glasgow's able debating qualities in the discussion. He said it was not profitable to lower the calorific power of the gas in order to reduce the price. This was entirely a question of locality. He would ask him in return, What is a suitable standard candle power, and a suitable standard calorific power, and what these figures are for a normal gas supply? Mr. Glasgow had taken from his figures in Table A, and had used in his averages, 594 B.T.U. net. This was much above the net calorific power of average coal gas or carburetted water gas, and only represented the gas from some 20 per cent. of the coals used at Nottingham. They were using about 70 per cent. of Derbyshire coal; and if he would turn to Table D, he would find that its average calorific power was about 502 and not 569 B.T.U. The average calorific power at Nottingham was 600 B.T.U. gross and 525 net.

Mr. GLASGOW remarked that the 594 represented the basis on which Mr. Brown worked when he arrived at the 480.

Mr. BROWN said he was afraid he could not agree with Mr. Glasgow as to the flame temperature being the same with all gases if combustion was perfect. As to the comparison

with the incandescent mantle, using alternately coal gas and water gas, he should be very sorry indeed if he could not get 22-candle power or more per cubic foot with rich coal gas. In this case, they were using water gas in an improvised burner adjusted temporarily for the purpose; and it was not a fair comparison to test it against the most efficient burner for coal gas. He had used one of Bray's burners (which was an excellent one) under exactly similar conditions to those with the water gas. He would once again ask gas engineers to exercise average intelligence, and believe he did not wish to impress upon them that it was impossible to get more than 15·7 candles per cubic foot with rich coal gas. Unfortunately, the British consumer still continued, through ignorance, to do himself the injustice of consuming gas in flat-flame burners; and possibly this was because very rich gases continued to be supplied. With regard to the cost of making blue water gas, the actual figure worked out at 1·3d. per 1000 cubic feet for manufacturing costs only, *plus* depreciation and wear and tear of the water-gas plant. Of course, the question of the depreciation of works depended very largely upon the point of view. If they were going to charge it with the whole of the wear and tear as well as the maintenance of the retorts, machinery, tools, works, &c., and the wear and tear and maintenance of the coal-gas plant and machinery generally, he thought such a course was most unfair to the process. The plant had been debited with its own repairs and depreciation; and by its use he was able to greatly reduce the cost of the repair and maintenance of the rest of the coal-gas plant. It would have been a much fairer method to have given it the credit for some of the so-called collateral advantages, and thereby have reduced the cost to some extent. Mr. Glasgow took an opposite view; but it was purely a matter of opinion, and must, of course, be left for each individual engineer to settle for himself. He had practically doubled the actual cost of manufacture *plus* wear and tear and depreciation (1·3d.), and thus arrived at his 2½d. per 1000 cubic feet, which he considered a very liberal sum; and even then this was not a fair interpretation of the case with regard to Nottingham, with present values.

Mr. Glasgow asked what items were included in the manufacturing cost.

Mr. Brown said he included coal, wages, fuel, repair and maintenance of the plant, and depreciation.

Mr. Glover remarked that the size of his retorts was not suitable, and that other retorts would give better results in carbonizing.

Mr. Brown said the best answer to that would be to refer Mr. Glover to the daily tables; and he suggested that it was impossible to get much better results with South Yorkshire coal. They were obtaining 12,140 cubic feet of 16·53-candle, 12,240 cubic feet of 17·17-candle, and 12,062 cubic feet of 15·68-candle gas. These were exceedingly good results; and he thought they afforded clear proof that they were getting practically the utmost the coal was capable of yielding. Possibly this was an answer to the suggestion that the retorts were not suitable for the coal used.

Mr. Glover said that was not his point. He simply suggested that some retorts that were suitable for making pure coal gas were not equally suitable for use with these experiments.

Mr. Brown said that if they examined the tables it would be found that before each series they gave the average of about 20 tests of the same coal in a testing plant, and they found on the adoption of this plant that they had an increase sometimes of 10, 15, or 20 per cent. above the best previous results obtained, due to the better conditions of carbonizing; showing that they were getting more than they had ever done before. This applied in every case; and if they got more under the new conditions than before, surely they were getting the best results possible.

Mr. Glover remarked that it was because all the bearings of the results obtained had been questioned so seriously that morning that he had brought forward this point. The author said that it would be necessary to carbonize coal throughout the series of tests under the same conditions. He (Mr. Glover) said that, on the contrary, using different coals under the same conditions would account for some of the variations in the results.

Mr. Brown said he understood Mr. Glover to suggest that using water gas required a different retort from that used for carbonizing coal by itself. They could not attempt to have a different shape of retort for every description of coal. They purchased ten to fifteen different varieties of coal at Nottingham. The erratic results at Rushden were in conformity with the results at Mariendorf and other places, and also at Nottingham until they got over the difficulties inherent in the process. He was pleased to know that with hot water gas Mr. Watson had gained 300 cubic feet per ton. With regard to the alteration of the tar, Mr. Copp's results and his own were exactly similar. He might say, in answer to the statement that the experiments were on a very small scale, that they were about 100,000 cubic feet per day, which was something like one-half the daily make at Mr. Watson's works. He had not sufficient time to answer Mr. Stephenson, or to refer to the very flattering statements of Professor Lewes. They would see by the illustrations that provision had been made for preheating the water gas. There was a 2½-inch coil placed in the main flue, and the water gas was sent in at a high temperature, with the unexpected result that preheating the gas did not improve the results—in fact, quite the reverse.

Petroleum Production in 1904.

H.M. Consul at Batoum (Mr. P. Stevens) reports that the actual production of crude petroleum at Baku during the past year was in excess of that for the year 1903; and if matters connected with the industry had worked smoothly during the year, doubtless this excess would have been more apparent than it is. But in view of the disturbed condition of affairs prevalent during the year in the localities where the wells are situated, and the frequent fires that occurred, by which large quantities of oil were destroyed, and the subsequent somewhat prolonged strikes, during which the output of oil, except from flowing wells, entirely ceased, the production was brought down to only a little more than 2,000,000 barrels in excess of the production of 1903—viz., 73,705,852 barrels, compared with 71,626,611 barrels.

Temperature of a Retort Charge during Carbonization.

Experiments made by Heer W. K. N. Geerling on the temperatures attained by the charge of coal during the time of its carbonization in a retort have been referred to in a recent number of "Het Gas." The temperatures were measured by means of Le Chatelier pyrometers, of which the thermocouple was carried to the core of the charge in the middle of the retort. At one hour after charging, the temperature there was 380° to 550° C; at two hours, 590° to 670° C; at three hours, 730° C; and at four hours, when the charge was nearly completely worked off, a little over 800° C. These figures show how slowly the interior of the charge acquires heat to raise it to the temperature of the walls of the retort. According to the author, our present methods of carbonization do not sufficiently take account of the very bad conductivity of coal, which is hereby displayed.

A French Report on the Earl's Court Exhibition.

Under the title of "Trois Jours à l'Exposition Internationale du Gaz à Earl's Court," M. Payet, one of the Secretaries of the Société Technique de l'Industrie du Gaz en France, has produced for the Society a very good account of what he and his colleagues saw on the occasion of their visit to London last December. The report opens with a brief reference to the inception of the exhibition, and an acknowledgment of the cordiality with which the members of the French Society were received on their arrival in London to inspect what was shown. The luncheon at Earl's Court and the banquet at the Hotel Cecil are duly noticed (a reproduction of the flash-light photograph taken at the latter being a suitable frontispiece); and an account is given of the visit next morning to the Croydon Gas-Works, of which there is a plan. These interesting incidents of the visit having been disposed of, M. Payet proceeds with his description of the exhibition. In his introductory remarks he explains how the idea of holding it came to be conceived, and gives the names of those who supported it and laboured in its realization; the lists of the exhibitors being presented in two forms, so as to permit of easy reference. Passing on to the exhibits, he begins with the retort-house and ends with testing apparatus; selecting for notice the plant and appliances which seem to him to present the most interesting features. It is unnecessary to refer to these in detail here. In addition to the illustrations given in the text, there are ten folding plates. In an appendix, M. Payet has an analytical study of the amount of transmission effected by a conveyor going at uniform speed. In his concluding remarks, he testifies to the advance made in the gas industry in England, and suggests that there is much room in France for an extended use of gas for domestic purposes. It only remains to say that M. Payet fully acknowledges the cordial assistance he and his colleagues received from everybody concerned in their inspection of the exhibits, and more especially from Messrs. Brackenbury, Martin, and Salomons, whose linguistic attainments were valuable aids to the thorough comprehension of the capabilities of the various appliances.

INSTITUTION OF GAS ENGINEERS.

OUTSIDE PRODUCERS FOR RETORT-HOUSES.

By ALEXANDER WILSON, M.Inst.C.E., of Glasgow.

[A Paper read at the Annual Meeting, June 1.]

If it is admitted as an axiom of gas manufacture that "dividends are made in the retort-house," it may well be claimed, as a corollary to that truth, that, "to insure good results in the retort-house, it is essential that the operations there should proceed at all times with regularity and despatch."

When stoking machinery had been installed in the Glasgow works, and the initial difficulties always associated with new methods of working overcome, it soon became apparent that many of the delays and irregularities were due to the fact that, in addition to the primary work of charging and discharging the retorts, the machines had another duty to perform—viz., the filling of the producers with fuel. The delays and irregularities were due to the difficulties of clinkering or cleaning the producers, and other causes; but, whatever the reason happened to be, the result was always the same—the retorts were not attended to at the proper time, and loss therefore occurred.

The late Mr. Foulis early recognized this obstacle to the perfect working of machines and retorts; and he decided to experiment with some producers placed outside the retort-house, where they could be worked independently of the machines, and thus maintain more regular working inside the retort-house. For the purposes of the experiment, a bench of eight through ovens was selected, each oven containing twelve Ω retorts, or 192 mouthpieces in all.

The tests were carried out at Dawsholm under the superintendence of the author; and a short history of the main points of these experiments, and the various steps taken, may prove of interest.

In the first instance, three rectangular producers were erected, of the design shown in fig. 1. The producers were lined with fire-brick and had fire-bars over dry ashpits, with Meldrum blowers providing a forced draught through the air-passages at the front. The coke was fed into the producers from hopper-bottomed waggons running on rails laid along the top of the producers. The openings into the fuel-chambers were sealed by moveable lids similar to those used on the generator of a water-gas plant. The gas was taken away through down-take flues (in which swinging dampers were fixed) into the bottom horizontal flue, which was sunk under the floor-level. This main flue was carried along both sides of the bench; and suitable openings were made in it for connections to the ovens. In each oven, passages for the fuel gas, in addition to those for the secondary air, had to be provided. This necessitated the whole of the brickwork under the retorts being rearranged. As the retorts were in fair condition, it was decided to support them on timber while the underwork was taken out and rebuilt; and this was successfully accomplished both at this time and on a later occasion when further alterations were required.

When the plant was started, the results obtained were not of any very promising nature. It was impossible to

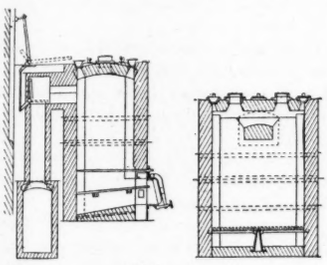


FIG. 1.

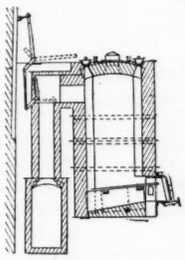


FIG. 2.

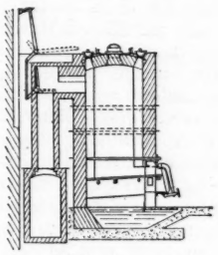


FIG. 3.

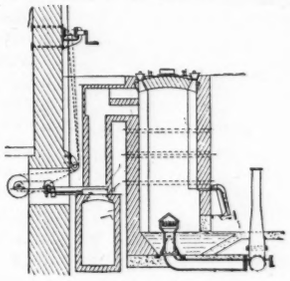


FIG. 4.

maintain a regular supply of gas, though a man was kept specially attending to the steam supply. This trouble was overcome by connecting the throttle-valve and compensator from one of the exhausters to the main steam-supply and the main outlet flue. Automatic regulation was thereby obtained; and, except on rare occasions, this arrangement has worked fairly well.

The difficulty of keeping the producers free from clinker proved, however, the most serious trouble. It was expected that the steam passing in with the air through the blower would keep the clinker friable; and the proportion of steam to air was altered, but with little avail. Various methods of clinkering were also tried, with no better results. The producers would run for a few days; and then the regular men would be unable to clear down the clinker, and an extra gang would have to be put on to assist them.

The producers were altered (fig. 2) so that a secondary set of bars could be introduced to hold up the fuel while the clinker was withdrawn. This proved of some help; but a large amount of coke came out with the clinker, and, at short periods, the whole of the fuel had to be taken out, and the sides of the producer cleared of the clinker as before.

In the ovens, it was found impossible to obtain sufficient heat. The retorts could only carbonize very light charges; and most of the coke produced was used as fuel.

On taking a series of observations, it was found that the fuel gas was entering the combustion chamber at a low temperature compared with the gas from the ordinary producers. This caused a much lower initial temperature in the ovens; and although the amount of gas per oven was much increased, no benefit resulted. It was, therefore, decided to try some alterations.

In the ovens, the heating surface of the fuel-gas flues was much extended, so that the entering gas might abstract more heat from the waste-gas flues, and so reach the combustion chambers at a higher temperature. In the producers, water ashpans were made; and some of the grates were fitted with moving fire-bars, as shown in fig. 3. These alterations improved matters a little, and enabled the work to be carried on over the busy season; but as soon as the plant could be spared, the section was shut down. When the flues, &c., were cooled, further alterations were determined upon.

In the down-take flues from the producers the swinging dampers, which had not been working well, were taken out; and sliding dampers (fig. 4) were put in at a lower level. The drums and handles for moving them were placed on the stage level, so that the men could operate them there. The fire-bars were entirely cleared away, and the producers arranged with water bottoms; the primary air and steam being introduced to the fuel through cast-iron rose-heads. The flues, &c., were cleared of the dust which had accumulated in considerable quantities; and various minor alterations also made.

Everything being ready, the producers were again lighted; but as soon as the gas was sent into the main flues, it was discovered that the joints of the top plates were leaking very badly. These had been jointed with "Vulcan" cement, and fixed with bolts about 12 inches apart. The expansion and contraction had slightly buckled the plates, and loosened most of the jointing. The closing of these leaks proved a rather dangerous operation. The author was aware of the poisonous nature of the gas to be dealt with; so great care was observed. Starting at the windward end, the men were only allowed to work for very short periods, and a strict watch was kept over them. They were inclined to treat the matter lightly, and thought too much fuss was made over what they considered an easy job. In spite of careful attention, however, several of the men were rendered insensible; the curious part of the business being that they did not feel upset while at work, but collapsed on going outside into the fresh air. The work was persevered in, and the leaks made tight. In addition, extra bolt-holes were drilled, and the bolts placed at 6-inch instead of 12-inch centres as before. It may be stated here that none of the

men seemed afterwards to suffer any ill-effects from their experience.

On similar occasions afterwards, when leaks were discovered, they were left alone until the flues were properly charged with gas. A lighted torch was then applied, which, besides causing the leaks to be easily seen, changed their character, and there was then no difficulty or danger in dealing with them.

The alterations which had been made on the ovens and producers proved of great benefit. The primary air, being introduced into the middle of the fuel-bed, had the effect of keeping the clinker comparatively light on the brick-lining, so that it was more easily detached, the working was made more regular, and the attention required was much lessened. It was also found that a more uniform quality of gas was being made. This improvement, added to the extra heating of the gas, due to the alteration of the regenerators, gave better heats in the ovens, and more satisfactory carbonizing results were produced.

The section was kept going for a considerable time, until it was found that sufficient gas was not being supplied to the ovens. This proved to be due to the flues getting blocked up again with dust; and, though the obstruction was removed in a temporary way, it got so bad, and affected the results so much, that it was decided to shut down, and get everything put in order for the winter season.

Advantage was taken of this stoppage to make further alterations. The main flue (fig. 5) at the producers was erected at a higher level, and connected to the producers by uptake flues, in which improved sliding dampers were placed. A large vessel to intercept the dust was also erected and joined to the main flue at the high level, so that the dust might be drawn off at suitable intervals before it could reach the underground flues, where there was difficulty in dealing with it while the bench was at work. The raising of the main flue also allowed the ash-pits to be extended on that side of the producers, so that the ash and clinker could be taken out more easily and effectively. An improved rose-head was adopted, whereby the accumulation of fine ash in the primary-air supply pipes was much reduced. Lattice girders were placed on the top of the producers to raise the rail-level. This allowed improved feeding arrangements to be substituted for the old style of generator lid; and, with this cone arrangement, the men were able to introduce the fuel into the producers more conveniently, and in much shorter time. Various other alterations were carried out where found desirable, and the plant was made ready to start.

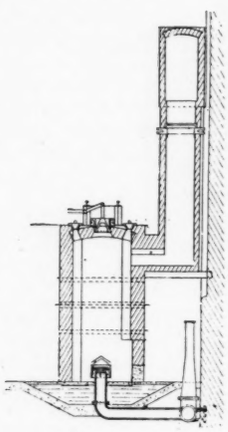


FIG. 5.

In starting the plant again, the usual care was taken to keep all lights clear of the flues, &c., while the air was being driven out through the temporary pipes connected up to the extreme ends of the main flues. On this occasion, however, the mixture of air and gas in the flues and dust-chamber must, by some means, have come in contact with fire, and an explosion took place, which caused considerable damage to the plant, but no injury to life or limb. An investigation as to the cause of the explosion was made, but no satisfactory solution was found. The plant was then put into order again with all dispatch, and a fresh start made. No trouble whatever was experienced on this occasion.

The various alterations that had been made showed improvement both in the working and results; and the section, during that and the following seasons, gave fairly satisfactory carbonizing returns.

The plant, after all this experimental work, was, as might be expected, not in a very good-looking condition. The retorts were worn out, and required to be renewed; so it was decided to erect a larger producer plant on a new site, suitable for two benches, or 360 mouthpieces.

Six producers of a larger size were erected, with all the necessary flues, &c.; the most important alteration being the substitution of "Duff" grates for the primary-air pipes with the rose-heads. The retort-bench was cleared out and rebuilt with improved regenerators, which gave still larger heating surface to the fuel-gas flues. A second bench was treated in a similar manner, and arranged so that the two benches could be worked together from one set of producers.

As soon as the work was completed, the section was started and carefully tested. It was considered that the results obtained warranted the recommendation that this system of heating should be adopted at the new works at Provan. In the designing of these works, the late Mr. Foulis was, at that time, busily engaged; but, as the members of the Institution know, he was cut off in the midst of his labours, and was not permitted to see the completion of even the first section of a grand works, which will ever be associated with his name.

Description of the Provan Producer Plant.

The general arrangement, fig. 6, shows the producer plant which is being erected for the No. 2 retort-house at Provan, which is similar to No. 1, and contains thirty ovens of twelves, or 360 through retorts in all. The ovens are arranged in four benches, each of which can be worked independently, or the two benches forming each half of the house can be worked in conjunction.

As will be seen, the producers are arranged in four sets of three; each set being connected up to one bench. The distributing flues supplying the benches Nos. 1 and 2, also 3 and 4, are made continuous; but dampers can be inserted between the benches when only one bench is required. Should both benches be at work, it is preferable to withdraw the dampers, and work the benches and sets of producers in conjunction. A more regular supply of gas is thus obtained during the process of cleaning. Each producer is cleaned once in 24 hours.

A platform to serve as a working stage is constructed at the level of the top of the producers, and extends the full length. An inclined road is connected from the ground level to the middle of the platform; and on this and the platforms, a narrow-gauge railway is laid and joined to the railways under the retort-house. By this means, the small locomotives convey the hot coke (in hopper-bottomed waggons) from the retorts to the producers.

Fig. 6 (as stated) shows the elevation of two sets of producers—making the group of six, capable of supplying fuel gas to one-half of the retort-house. The production of gas in each set is automatically regulated by a governor which actuates a throttle-valve on the main steam-supply pipe leading to the blowers; the gas-bell being connected to the main flue, and controlled by the pressure therein. The bell can be weighted to give the pressure required. The position of the dampers in the uptake flues is shown, also the top main flue and the position of the dust-chambers.

Fig. 7 shows a sectional elevation of three producers, with a cross section of the dust-chamber. Fig. 8 shows a cross section of the producers and flues.

The producers are steel casings; the inside dimensions being 9 ft. 4 in. by 6 ft. 4 in. by 13 ft. 3 in. high. They are lined with fire-brick 11 inches thick, and have each a cross-area (inside the fire-brick lining), of 33 square feet, and a depth above the fire-grate of 9 feet. They are arranged with water-sealed ashpits, from which the ash and clinker can be shovelled out into tipping waggons running on rails laid on both sides of the producers. "Duff" grates and blowers are fitted to each producer. These distribute the primary air fairly equally over the fuel area. Each producer has, in the top plate, two charging openings, with hanging plugs or cones by means of which the coke is charged into the producers from the hopper-bottomed waggons, with little trouble, and small loss of gas. There are also eight clinkering openings, covered with cast-iron plugs. These are arranged round the top, so than any clinker which may grow on the fire-brick lining can be cleared away. Lattice girders, carrying the rails for the coke-waggons, are also fixed on the top of the producers. The exit flues are taken from the sides of the producers, and join the uptake flues, at the top of which—before they join the main flues—the dampers are fixed. The damper-frames are of cast steel of channel section, and are arranged with water-tanks and circulating pipes, to assist in keeping them cool. The damper is of cast iron, and is worked by chain-gearing from the platform, as shown.

The main flue is circular; the inside diameter of the casing being 4 ft. 10 in., and the inside diameter of the

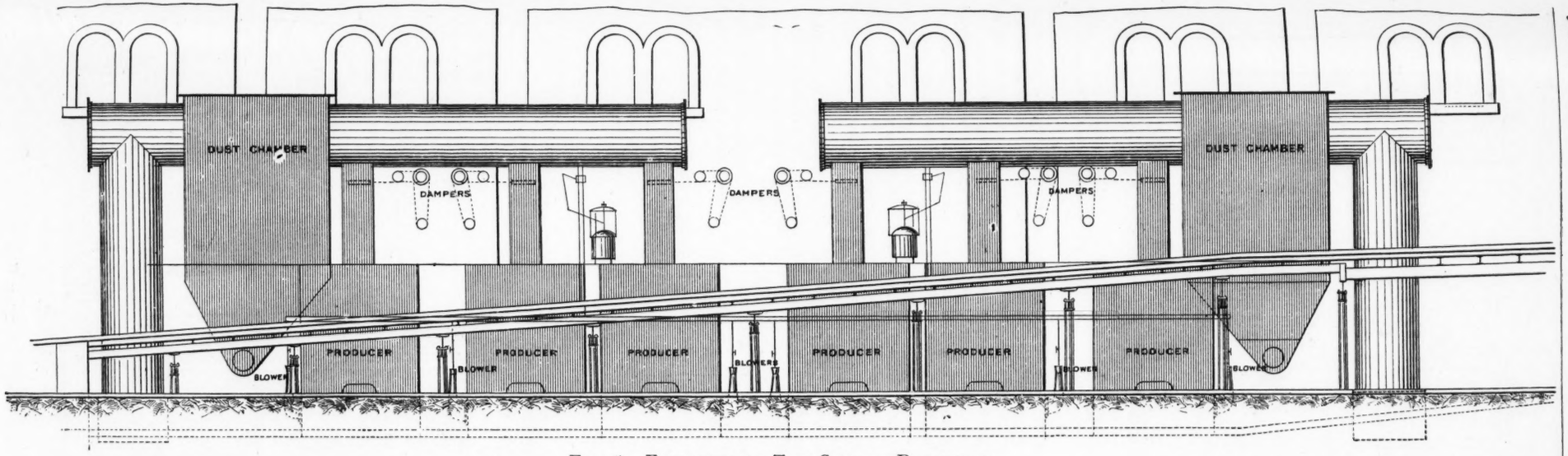


FIG. 6.—ELEVATION OF TWO SETS OF PRODUCERS.

fire-brick lining 3 ft. 9 in. A layer of slag wool, 2 inches thick, is inserted between the casing and the fire-brick lining. It is placed all round the circular flues, and on the top and sides of the rectangular flues and dust-chambers, in order to minimize the loss of heat by radiation.

The casings of the dust-chambers are 11 ft. 3 in. long, by 6 ft. 10 in. wide, by 22 ft. high. They are also lined with fire-brick and formed with tapered bottoms to facilitate the discharge of the dust through the mouthpieces provided at the lower ends. The current of gas is directed downwards by brick diaphragms, and then allowed to ascend through a larger area—giving the dust time to settle in the chamber, from which it can be discharged as required. Two explosion valves are fitted on the top of each chamber. The downtake flue from the dust-chamber is circular; but in the retort-house the flues are of rectangular section. The distributing flues on each side of the retort-benches are 3 ft. 8 in. high by 3 ft. 7 in. wide; the gas-passage being 2 ft. 6 in. by 2 ft. 9 in.

Two vertical connections are made in front of each oven. In these, sliding fire-clay dampers are placed to regulate the supply of gas; and the connections are so arranged that, when an oven has to be shut down, the front plate is taken off and a cast-iron plug is bedded over the opening. At the same time, the opening into the oven is closed up, so that, should any escape of gas occur, it can easily be detected and stopped.

A certain amount of dust is found to get past the dust-chambers, and is carried forward into the distributing flues. These have, therefore, been provided with suitable cleaning doors at convenient positions, so that the dust can be extracted, if necessary, even while the plant is in action.

Fig. 9 shows the construction of the retort-settings with the regenerators arranged for the heating up of both the secondary air and the fuel gases.

STARTING THE PLANT.

When the plant is completed and ready for work, it is advisable that the whole of the brickwork should be properly dried before the producers are lighted. This is accomplished by making coke-fires in the flues, and also in front of each oven; the heat being allowed to pass through the oven by means of the fuel-gas and secondary-air channels in the regenerators. When sufficient heat has been applied, the fronts of the ovens are built up and completely isolated from the distributing flues. This is done for two reasons—to retain the heat in the ovens, and also to prevent any fuel-gas getting into the ovens before the proper time.

At the extreme end of each distributing flue, a 6-inch malleable iron pipe is connected and carried up through the roof, to provide means of blowing away the air and the first portion of the gases which are made in the producers. A steam connection is also joined up to the end of the circular flue above the producers.

When the producers are to be started, a small fire of hot coke or wood is placed in all the producers of the section, which are then filled up with cold coke, and the blowers turned on, but only slightly at first; the products of combustion being allowed to escape through one of the clinkering openings. The damper of the outside producer is then opened, and also the steam connection into the main flue. The steam to the blower of the outside producer is gradually increased, while a pressure is maintained in the other producers.

The production of gas is continued until samples drawn from a suitable connection in the vent pipe show the gas to be of good quality. The steam connection is then shut off, and the gas is ready to put into the ovens.

To light the ovens, the brick-stopping is taken out, and a wood fire made behind the fuel-gas opening in the vertical connections. The cast-iron plug is then withdrawn, and the damper slightly opened. The gases, in passing over the wood fire, are ignited; and, the bench being hot, sufficient draught is obtained to carry the gases through the oven. The remaining ovens are treated in a similar manner, when

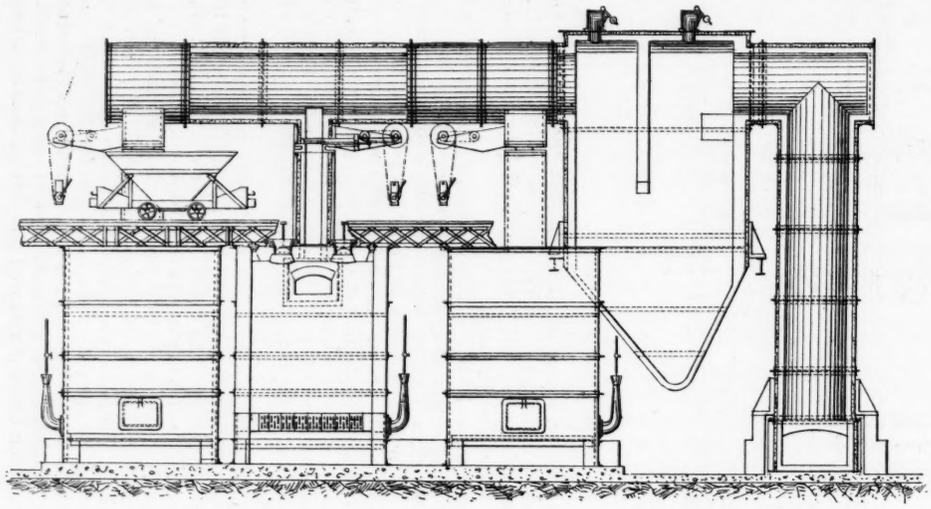


FIG. 7.—SECTIONAL ELEVATION OF THE PRODUCER PLANT, PROVAN GAS-WORKS.

CROSS-SECTION OF THE DUST-CHAMBER.

the 6 inch malleable iron pipes are shut off and disconnected. For safety, a coal-gas jet is kept burning over each fuel-gas inlet until the flues are heated to a sufficient temperature to ignite the gas, should the flame from any cause become extinguished.

The amount of gas to the ovens is gradually increased until the bottom rows of retorts are heated to redness. The supply of air to the bottom opening is then gradually restricted and closed up, while sufficient air for combustion is supplied through the usual secondary-air ports.

When the ovens are being heated and put to work, tests are made of the waste gases; and the various dampers are arranged in the usual way to give the best results.

WORKING RESULTS.

The producer plant installed at Provan for No. 1 retort-house has worked well from the start. Various qualities of gases have been experimented with by regulating the proportion of steam in the primary air supply. It is found that the best results are obtained by having the proportion of steam low, consistent with keeping the producers in good working order. The producers are in fact run as hot as possible; but the formation of heavy clinker is avoided.

This method of working is the opposite of that employed in power-gas plants where a superabundance of steam is used to conserve the available heat in the producers, and give a high percentage of hydrogen in the gas. The reason for this difference in working is that in the one case the gas has to be distributed and used cold, and in the other it is advantageous to carry the gas to the ovens at as high a temperature as possible.

In stating the results obtained at Provan, some comparisons are made with results obtained under the ordinary methods of working at the Dawsholm works, as practically the same conditions apply in each case, especially with regard to the quality of coal carbonized, the coke from which is of a rather inferior quality, and contains a high percentage of ash.

Fuel gases made in the large producers at Provan, and

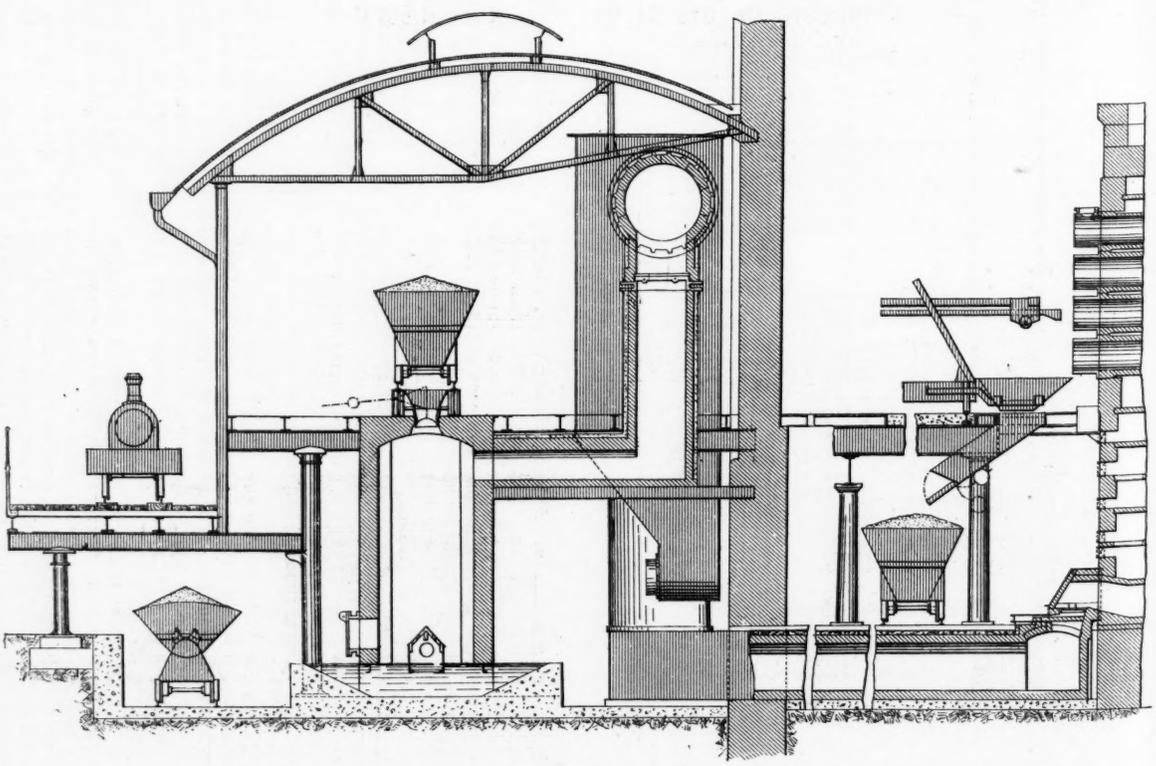
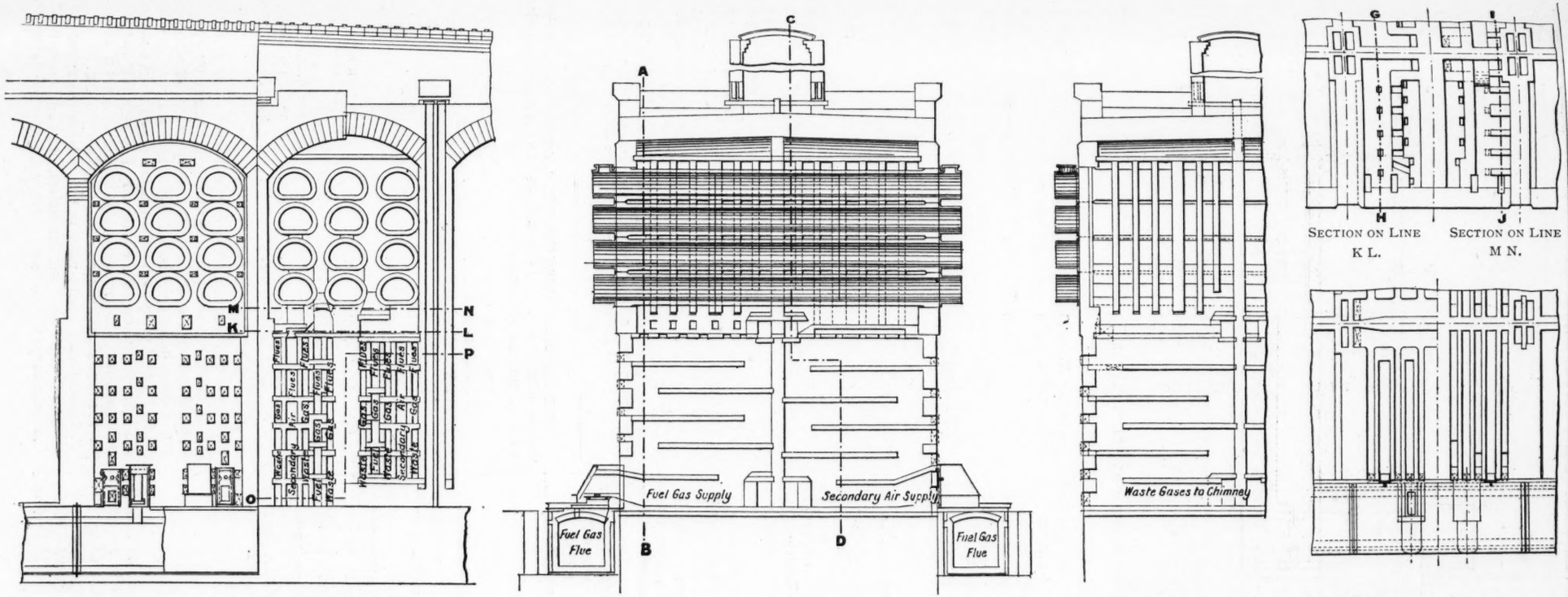


FIG. 8.—CROSS-SECTION OF THE PRODUCER PLANT, PROVAN GAS-WORKS.



FRONT ELEVATION. SECTION ON LINE A B. SECTION ON LINE C D. SECTION ON LINE E F. SECTION ON LINE G H. SECTION ON LINE I J. SECTION ON LINE K L. SECTION ON LINE M N. SECTION ON LINE O P.

FIG. 9.—DETAILS OF RETORT-SETTINGS, PROVAN GAS-WORKS.

the ordinary producers at Dawsholm, have the following average percentage compositions :—

—	PROVAN. Large Producers.	DAWSHOLM. Ordinary Producers.
Carbonic oxide	30·50	27·0
Carbonic acid	3·80	5·4
Hydrogen	12·06	7·5
Nitrogen, by difference	53·64	60·1
Heating value by Junkers calorimeter	140 B.T.U.	118 B.T.U.

The waste gases from the ovens give an average percentage analysis of :—

—	PROVAN. Large Producers.	DAWSHOLM. Ordinary Producers.
Carbonic acid	17·0	15·4
Oxygen	1 2	2·2
Nitrogen by difference	81·8	82·4

LOSS BY RADIATION.

Compared with ordinary producers placed under, or in close proximity to the ovens, much greater loss by radiation is to be expected from this system, owing to the exposed position of the outside producers, and the large surface area of the connections. To reduce this anticipated loss, the flues have been built with a layer of slag-wool between the brickwork lining and the steel casings; and, in addition, one section of the flues has had a covering of diatomite non-conducting material placed over the most exposed parts.

To determine the loss, holes were bored in the flues at various positions (as shown in fig. 10), and temperatures were taken at these points by means of an electrical pyrometer. As marked on the plan, the temperatures were

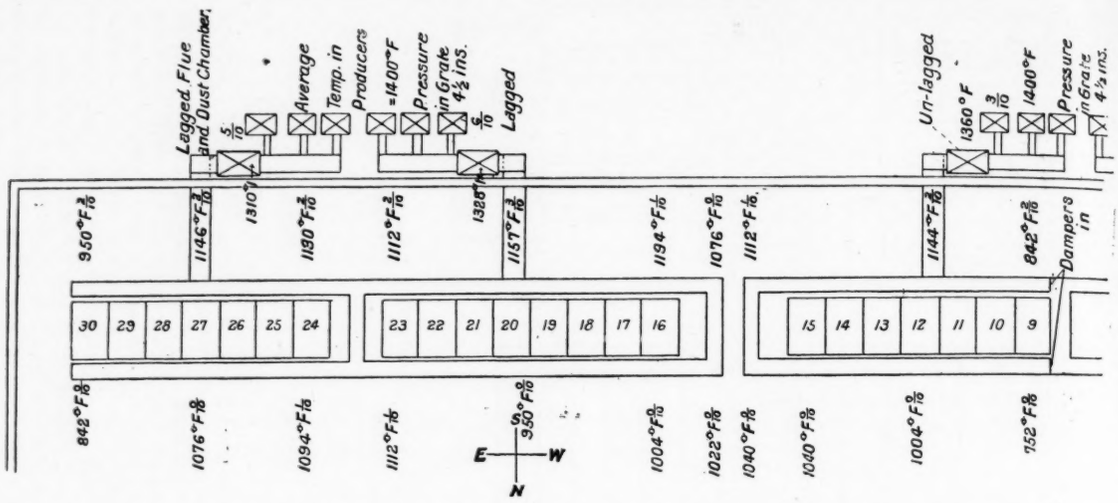


FIG. 10.—TEMPERATURES AND PRESSURES IN THE FURNACE FLUES.

found to range from 1400° Fahr. on the top of the fuel bed of the producers, down to 842° Fahr. at the extreme end of the flue in the section which had been lagged outside, and to 752° Fahr. at the extreme end of the section which was only protected by the layer of slag-wool. The mean temperature of the gas entering all the ovens may be taken at 1018° Fahr., or 382° Fahr. below the temperature on top of the fuel bed of the producers. This represents a loss of less than 4 per cent. of the total heat available for use in the ovens.

To ascertain the loss due to friction in the flues, pressures were taken at the various points; and these will also be found marked on the sketch plan. The pressures vary from 6-10ths of an inch of water at the producers down to level gauge at the ends of the section. It is considered advisable to maintain a level gauge, or a slight pressure in the flues, so as to prevent air being drawn in, and so cause local heating.

To determine the effect on the working of the ovens of the loss of heat by radiation in the flues, a series of observations were taken. They indicate that, where the fuel gas enters the oven at the higher temperatures, better carbonizing results are obtained, although with the high heats worked in Glasgow, and the large amount of waste heat going to the chimneys, the effect is not so marked as might have been expected. The very large heating area now provided in the regenerators gives the fuel gas and the secondary air better facilities for abstracting the heat from the waste gases. That this extra surface is necessary is shown by the observations taken.

Temperatures in Regenerators (Degrees Fahrenheit).

Oven.	Fuel Gas.		Secondary Air.		Waste Gas.	
No. and Side.	Entering.	Leaving.	Entering.	Leaving.	Entering.	Leaving.
15—N	1040	1931	63	1877	1976	1355
9—S	824	1859	63	1760	1958	1238
19—S	1080	1976	63	1913	2012	1544
29—N	749	1868	63	1778	1868	1150

The temperatures observed in the ovens under the first row of retorts were from 2100° to 2200° Fahr., and a temperature taken inside one of the retorts, immediately after drawing out the coke, was 1508° Fahr.

Fuel Results.

To obtain a fairly reliable comparison of the amount of fuel used in the outside producers, compared with the small Siemens producers installed in the other works, a test was made for a week in each case, under as nearly as possible similar conditions. Table I. gives details, for Provan, of the coals carbonized, with figures relative to the amount of coke produced, &c. These details are stated to show how the results tabulated in the summary were arrived at.

TABLE I.—*Fuel Results at Provan.*

No. of Coal.	Quantity Carbonized.	Coke Produced per Ton. (Ex. Coal-Test Book.)	Ash in Coke. (Ex. Coal-Test Book.)	Estimated Total Coke Made.	Estimated Total Ash in Coke.
	Tons.	Lbs.	Per Cent.	Lbs.	Lbs.
1	209·25	1245	17 43	260,516	45,407·93
2	167·75	1122	10·60	188,215	19,950·79
3	130·50	1260	17·78	164,430	29,235·65
4	161·25	1282	33·17	206,722	68,569·68
5	70·35	1162	6·52	81,746	5,329·83
6	56·10	1225	11·51	68,722	7,909·90
7	372·55	1460	10·00	543,923	54,392·30
8	51·60	1270	3·35	65,532	2,195·32
9	63·40	1497	8·70	94,909	8,257·08
10	7·50	1375	11·95	10,312	1,232·28
11	116·50	1305	12·33	152,032	18,745·54
12	163·40	1325	7·20	216,505	15,588·36
13	21·50	1355	8·00	29,132	2,330·56
14	134·40	1244	13·71	167,193	22,922·16
15	80·85	1370	8·50	110,764	9,414·94
16	79·85	1297	5·10	103,565	5,281·81
17	499·15	1330	9·40	663,869	62,403·68
18	377 50	1320	7·00	498,300	34,881·00
19	125·60	1275	7·50	160,140	12,010·50
20	6·80	1250	9·77	8,500	830·45
Totals	2895·80	Aver. for test, 1310	Aver. for test, 11·24	3,795,027	426,889·76

The remainder of the coke, after the producers had been provided for, was carefully weighed; and the returns for Provan were as follows:—

Fine breeze	196·80 tons.
Screened breeze	211·85 ,,
Coke	1091·60 ,,
	1500·25 tons.
Deduct for moisture (20 per cent.)	300·05 ,,
Coke sold	1200·20 tons, dry = 2,688,448 lbs. ,,
Coke made	3,795,027 ,, ,,
Coke used as fuel	1,106,579 ,, ,,
,, ,, ,,	29·16 p.ct. of coke made.
,, ,, ,,	17·06 lbs. per 100 lbs. of coal carbonized.

The ash and coke removed from the producers during the test amounted to 128·36 tons; and it was found by experiments that 26 per cent. of this quantity was unburned coke. If this quantity of coke be taken into account, it will reduce the fuel used by 1·9 per cent., and the quantity of coke per 100 lbs. of coal carbonized, by 1·15 lbs.—making the percentage of fuel used 27·26 per cent., and the amount of coke per 100 lbs. of coal carbonized, equal to 15·91 lbs.

There is more steam used in the outside producers than in the ordinary ones; but the amount has not been noted.

A summary of the tests made at Provan with retorts

working four-hour charges, and outside producers, and at Dawsholm, with retorts working three-hour charges, and small Siemens producers, is as follows:—

—	Provan. Outside Producers. Four-Hour Charges.	Dawsholm. Ordinary Producers. Three-Hour Charges
Duration of test	6¾ days	6¾ days
Mouthpieces in action	528	300
Total coals carbonized	2895·8 tons	1784·05 tons
Weight of coal carbonized per mouthpiece per 24 hours	16·45 cwt.	17·84 cwt.
Coke per ton of coal (ex. coal-test book)	1,310 lbs.	1344 lbs.
Total coke made—dry	1694·208 tons	1070·43 tons
Total coke sold, less 20 per cent. for moisture	1200·20 ,,	708·868 ,,
Total coke used as fuel	494·008 ,,	361·562 ,,
Percentage of coke made used as fuel	29·16 per cent.	33·77 per cent.
Coke for fuel per 100 lbs. of coal carbonized	17·06 lbs.	20·26 lbs.
Ash and clinker taken from producers	128·362 tons	..
Coke in ash, &c.	26 per cent.	..
Equals percentage of coke made	1·9 ,, ,,	..
Equals pounds per 100 lbs. of coal carbonized	1·15 lbs.	..
Coke used for 24 hours per square foot of producer area	558 ,,	..

Working Costs.

To obtain a comparison of the working expenses between carbonizing work done with this system of outside producers and the work done with small ordinary producers, details of wages are given for obtaining the same return of work in each case. In addition to the labour at the producers, the work in the retort-house from the opening and cleaning of the lids, for the machine to draw out the coke, until the coke is either trimmed into the coke bogie or put into the producers, has been included.

—	Provan. Outside Producers. Four-Hour Work.	Dawsholm. Small Producers. Three-Hour Work.
Number of retorts	360	360
Number of producers	6	45
Total coal carbonized per 24 hours	296·10 tons.	321·12 tons.
Coal carbonized per retort, do.	16·45 cwt.	17·84 cwt.
Number of men, do.	21	46·5
Total wages, do.	£5 1s. 3d.	£11 12s. 10d.
Cost per retort, do.	3·37d.	7·75d.
Cost per ton of coal carbonized	4·10d.	8·70d.
Saving per ton in favour of outside producers	4·60d.	..

This difference, of 4·6d. per ton of coal carbonized, does not represent the total saving in wages, but only the saving in the section of the work in which the comparison can definitely be made between the two systems.

As stated at the beginning of the paper, the principal reason for the adoption of this system of outside producers was to obtain more regularity of working in the retort-house. This desirable end has been accomplished, with all collateral advantages; and at the same time other benefits have accrued. The work of the firemen, and the outlay for their wages, has been considerably reduced; also the cost of upkeep for their tools (usually no small item) has almost disappeared.

While there is some extra loss due to radiation from the flues, &c., the percentage of fuel required is less than that for retorts heated by ordinary producers. This is no doubt due to the more regular supply of gas, both as regards quantity and quality. As the result of this regularity, the ovens require less attention, as, when once the dampers have been properly adjusted, there is seldom need to alter them.

This method of making the production of fuel gas a separate and independent part of the works, has been in vogue in other manufacturing concerns for many years, and has conferred many benefits on those who have adopted it. In gas-works where retort-house machinery is used, there is an undoubted field for it; and its general adoption in gas-works is to be looked for when gas manufacture by means of the vertical retort takes the place of present methods of carbonizing.

Discussion.

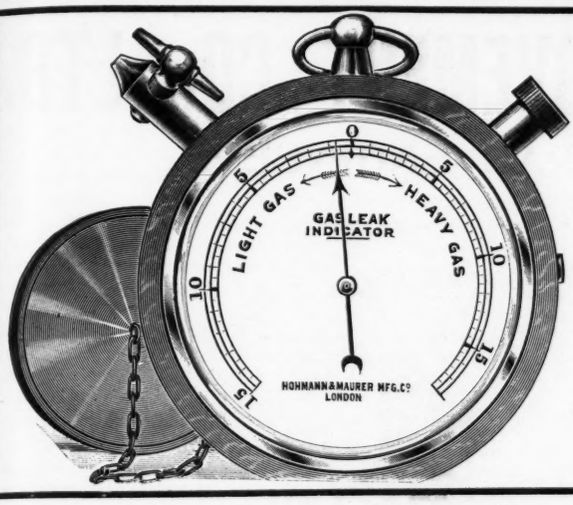
Mr. R. Bruce Anderson (London) said their thanks were due to Mr. Wilson for his very practical paper, which was a great relief after the theoretical one that morning. His attention had been drawn for more than ten years to these external producers; and he had had them in use for that time. The idea had formed itself in his mind from the kindly interest which Mr. Foulis took in him. As a lad, he used to call on him; and he was always fond of chatting on scientific matters with those who took an interest in them. It appeared to him that in the Provan and Dawsholm producers there was a great loss by radiation; and it seemed that in the design of the producers they rather courted disaster in this respect. In the first place, the producers seemed comparatively small for the amount of work to be done. They had three of them to each unit; whereas it occurred to him that two larger ones would have been equally effective, and would have exposed less surface to radiation. He also noticed that the shape of the producers was rectangular; but cylindrical ones were generally much favoured for various reasons, and he should like to know why this departure had taken place. There was certainly a larger area in the producer; but for the amount of radiation, the area was smaller. Ten or twelve years ago, he came to the conclusion that the best place for the producer was outside the setting. To-day he put the producer at the side of the ovens, which were about 9 feet wide. The producer was about 33 inches wide inside, which was amply sufficient to heat sixteen retorts 24 inches wide. There was very little lost by radiation in consequence of so taking the producer outside. [Mr. Anderson then drew a sketch on the blackboard of the manner in which his retort settings and producers were arranged.] The increased area for radiation was not materially increased, bearing in mind that the cold wall of the producer was not at such a high temperature as the old cold wall of the setting used to be, which was adjoining the hot oven. In the case of the Provan producers, they had a much larger area exposed to radiation. He did not understand why they should go right outside the retort-house altogether. His idea would be to have the producers by every bench of beds, where they could be easily accessible from the outside or the side; and one could get a large grate, and thus be able to fire half-a-dozen settings from one producer. By having the producer at the end, one could keep the settings going for years without having to let them down. If one got burnt out, the other could be lit while it was being repaired. With regard to the size of the flues, this had been controlled, he understood, by the amount of dust which was formed; and he should suggest that the introduction of a curtain into the producer would be a distinct improvement in that respect. The dust had been so serious that they had actually to erect a dust-chamber at Glasgow to take it out before introducing the producer gas into the settings. This, again, exposed a great deal more area to radiation—still further reducing the temperature. By using a curtain in the producer, two advantages were secured—there was maintained a constant depth of fuel, 3 ft. 6 in. or whatever was decided on, and this remained constant, whatever amount of fuel was used, assuming it was not allowed to burn down to unseal the curtain. Another advantage was the retention of the dust, which did not come so much from the burning fuel, in his opinion, as from the mechanical operation of throwing the coke into the producer—one had a lot of dust stirred up, and this was swept away through the flue into the dust-chamber; whereas, if the coke was put in above the fuel in the producer, and one kept the curtain sealed, the dust subsided among the fuel and was burnt, instead of being carried into the settings. Mr. Wilson had referred to the explosions they had had; and he might say that he also had experienced trouble with explosions with these beds. They always occurred at first lighting-up, before the settings got thoroughly dry. He gathered that it was in the first lighting-up that Mr. Wilson had had the explosions referred to; and he found it advisable afterwards to thoroughly dry the setting by means of fires on the floor. They came to the same conclusion; and in lighting up the settings they always built a fire on the floor, and heated up the arches from the outside, so as to warm up the arches and nostrils before sending the producer gases forward. The paper contained a few words on the analysis of the gas; the Provan and Dawsholm gas being put side by side. This table, he thought, would be much better

(and he wished gas engineers would note this) if they were to take as a common denominator 79 or 80—the percentage of nitrogen in the air—as a base for their calculations, and, instead of saying so much per cent. of the ultimate gas, say so much for every 79 volumes of nitrogen, or so much per cent. of the original air primarily used for combustion. The figures given were upset by the quantity of hydrogen. If one made an allowance for this, and the carbonic oxide produced from the oxygen of the steam, making the necessary corrections, one would find that the carbonic oxide in the gas at Dawsholm was 19, and at Provan 20. So that it would look as if the primary air in the two producers was giving practically the same effect. The paper also gave the temperatures in the regenerators; and he was very much struck at finding what a little difference there was between the waste gas entering the regenerators and the fuel gas leaving. Take the last one, for instance. The fuel gas was entering at 749°, and leaving at 1868°—identically the same temperatures as the waste gas entering. He did not feel any doubt as to the accuracy of these figures. If one took the figures higher up, they were also very nearly identical—1976° against 2012°. It occurred to him that there must be some combustion taking place in these regenerators, and there must be some leakage between the fuel gas and the air, causing increased temperature to arise from combustion in the regenerators rather than from transmission through the flues.

Mr. J. H. Brown (Nottingham) desired to thank Mr. Wilson for his very instructive and interesting paper; but, in listening to his closing remarks, the thought occurred to him: "Why did not the author go one step farther and abolish all the numerous small generators, and erect a Mond gas plant for supplying the whole of his works, and possibly some outside consumers?" Mr. Wilson had six or seven generators making producer gas of a calorific power of about 140 B.T.U. This gas had of necessity to be heated by the waste gases from the settings before being used; and, in spite of this, the waste gases were leaving the settings at a very high temperature. He was also losing a considerable amount of heat by radiation and from other causes. Surely, on a works of this magnitude, it would be advisable to adopt a Mond gas plant, which would produce all the gas he required with one generator, and this gas would have a heating value of 150 to 153 B.T.U. It certainly would be made cheaper by using one generator instead of six or more, and he would have, in addition, a very large saving, due to the recovery of sulphate of ammonia. This increase in the quantity of sulphate might very possibly depress the market for this product; but, of course, that was for other people to consider, not for Mr. Wilson. A large saving in labour and fuel would, no doubt, be effected; and the gas produced by the Mond process would require heating very little, if any, more than the gas of a lower calorific value which the author was now producing. Of course, it all hinged on the question of coke. The Mond gas people guaranteed that their producers would work just as well with coal as with coke; and many works were now using coke for the production of Mond gas. He had no doubt that a large installation in duplicate would be very much more satisfactory in working than the very many small producers Mr. Wilson had in operation. There was a further great disadvantage in these small generators, that they were only suitable for large works where they had plenty of space available; and they necessitated having steam-boilers in various parts of the works. He (Mr. Brown) had been trying, as far as possible, to minimize the steam-generating plants by using gas-engines wherever he could. In some cases, they were being employed practically in the retort-houses themselves. In order to avoid the use of steam in the regenerator furnaces, he had adopted V-shaped bars in them, and used a considerable quantity of water to generate the necessary steam.

Mr. W. Doig Gibb (Newcastle) said the paper was peculiarly interesting to him. Some years ago he had an opportunity of seeing producers on somewhat the same principle which Mr. Carpenter had at work at the Old Kent Road. Since that time he had gone into the subject somewhat carefully; and there seemed to be no doubt that something on the lines that Mr. Wilson had been speaking about was an advantage for large works. Apart altogether from the question of the comparative cost of working, he thought it impossible to over-estimate the immense advantage gained in removing the producers from the retort-house, and so being able to get the best possible value out of the expensive machinery installed therein. There was no doubt that by removing the producers outside, and simply bringing the gaseous fuel into the house, it was possible to get a much more completely equipped house for working by machinery. He did not propose to go into the figures; but one thing that struck him was the evident difference between the qualities of Scotch coke and the average English coke. Probably the difference between the cokes would make it rather difficult to draw accurate conclusions as to what might be the figures when using a better coke than Mr. Wilson had at his command. There was one question which he should like the author to touch upon in his reply. No doubt in Glasgow, which was a very large place, Mr. Wilson might be able to see his way to lay down and charge up his retorts in large sections of about 60 mouthpieces apiece; but he (Mr. Gibb) would like to know if Mr. Wilson had experimented at all in the direction of running one set of these outside producers when the production of gas from them was only required for part of the total number of settings that they could work. To put it shortly, if the works were of such a size that the manager could not heat up and lay down in blocks of 60 mouthpieces, and had to run a 60-mouthpiece producer to get fuel for only 30 or 15 mouthpieces instead of the full number, what would be the percentage of loss as compared with its most economical working, which would be when running at its fuil capacity? The only other point he might mention was the accident which occurred, when the men were overpowered with the gas. It seemed to him that this emphasized the fact, which was now pretty well acknowledged, that in works of any size one of the most handy things to have was a portable steam-engine. It was surprising to what a variety of purposes such a tool could be put. Not only could it be used in cases where the ordinary power had broken down, or where some auxiliary temporary power was required, but, in combination with (say) a Roots blower, nothing ensured greater safety to the workmen. The blower could be very easily fitted in front of the engine, and whenever men were at work in any confined space—below purifiers, in gasholders, or anywhere where there was some danger from gas—it was an easy matter to bring the engine near the place, start the blower, and lead a strong current of air through a length of armoured hose. He had found this to be a great advantage; and the small initial cost was infinitesimal when compared with the extra safety obtained when working where there was any danger from gas.

Mr. J. F. Bell (Derby), after congratulating Mr. Wilson on his paper, said he believed the late Mr. Denny Lane was the first, in conjunction with Mr. Travers, to use outside producers for gas-retorts. This was about fifteen years ago; but they turned out a failure, principally, he believed, owing to the great loss of sensible heat of gases due to the producers being placed at some distance from the retort-house, and there were no means of heating up the gas and air. They must all thank Mr. Wilson for telling them of the difficulties he encountered. Within the last year or two he (Mr. Bell) had put down a producer on the lines suggested by Mr. Carpenter—a producer to heat six beds; but, so far, it had not been a conspicuous success. They found great difficulty in regulating the amount of gas for the different settings; and he should like to know if Mr. Wilson experienced any difficulty of this kind. He found that, with a change of wind, one side of the retort-house would get hot while the other would get comparatively cool. Another thing which struck him was this: Mr. Wilson said he had about 360 mouthpieces, and for some time the carbonizing results were not wholly satisfactory. For Glasgow, 360 mouthpieces was perhaps a small unit; but for an ordinary-sized works it would be a very serious thing if they had these outside producers and anything happened to them. Would Mr. Wilson give them the cost of the producers shown on the diagrams? It appeared to him that the cost would be considerable; and he should like to know what saving there would be, if any, in the constructional cost between these and one producer for each through setting. The figures of coke consumption seemed to most English gas engineers somewhat high; but Mr. Wilson had explained this by telling them of the very poor quality of the coke. When he was in Glasgow, he saw coke there which he did not think anybody in England would buy. They found that testing the spent gases of the setting daily for the percentage of carbonic acid was a very good



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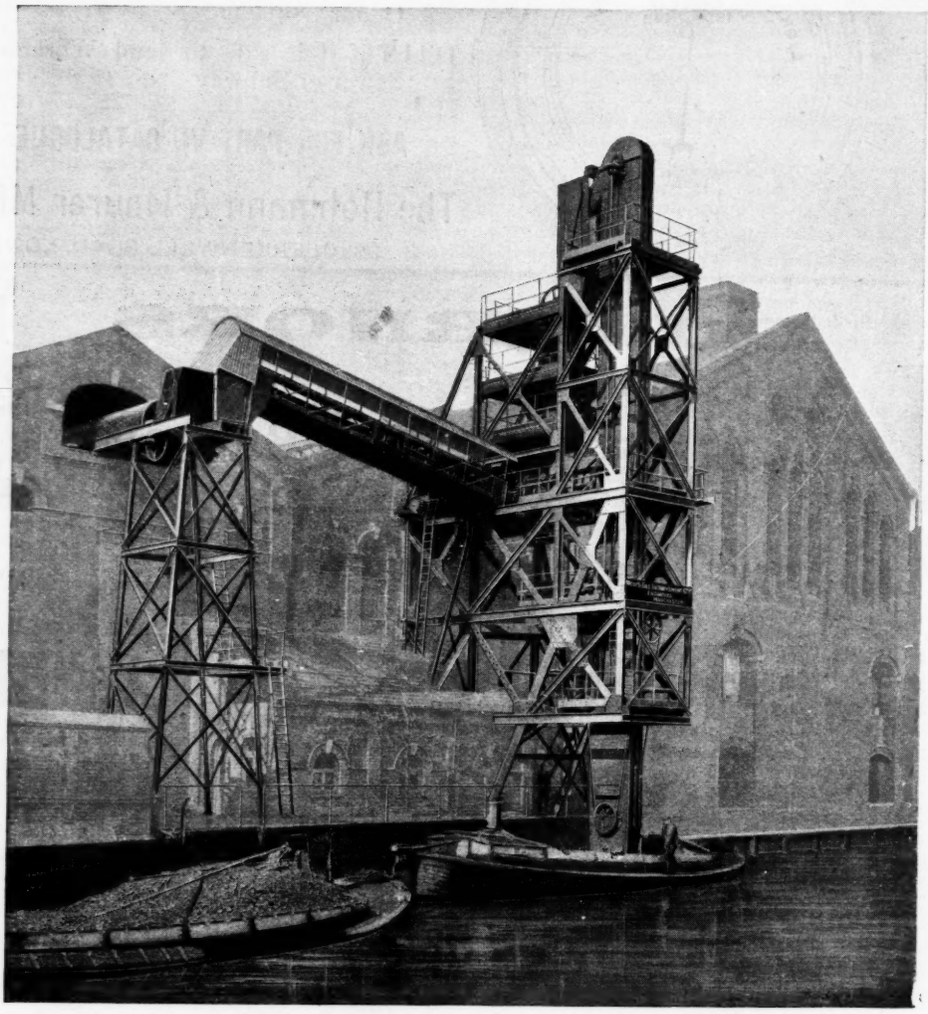

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criterion of the way the beds were working; and he thought the figure Mr. Wilson gave, of 17 to 18 per cent. of carbonic acid in the spent gas, was very good. These were about the same figures that he got. In working a large producer and one to each setting, they found no difference in coke consumption. Further, they found difficulties in clinkering the large producer; and, taking it altogether, there was no real benefit so far.

Mr. J. H. Brearley (Longwood) thought that, on taking a survey over the last ten or twelve years, they were bound to admit that they were making very slow progress in this matter. Mr. Bell confessed that he had found it somewhat of a failure; indeed, very few large works seriously entertained the idea of outside producers. They could therefore all the more admire Mr. Wilson's success with this particular form of gaseous firing. To an engineer in charge of small works it did not present so much fascination as to the engineer of large ones, where other factors besides mere economy of fuel had to be considered. In this case, the question of machine charging had to be taken into consideration. One point he was not quite clear about. He had been struck with the large expenditure for fuel, which Mr. Wilson explained and Mr. Bell confirmed. But in another paper, which was later to be taken as read (that by Mr. Herring), he found the figure for Scotch fuel per 100 lbs. of coal carbonized was 12·89 lbs. in 1904, and 10·95 lbs. in 1905; whereas in Mr. Wilson's paper, even at Provan, with this outside producer, it was 17·06 lbs. He did not know anything about the relative values of the coke used at the two works, and should be very glad if Mr. Wilson could enlighten the members on this point.

Mr. J. G. Tooms (Waterford) said he desired to speak not so much on the subject of large outside producers, as described by Mr. Wilson, but rather on the principle of producers, such as had been shown by Mr. Anderson on the blackboard. For the last five years he had been working solely with these producers, not fixed underneath the retorts; and, without any regeneration, they were able to sell nearly 10 cwt. of coke per ton. From a moderate-sized works, this was a result which was not to be ashamed of, especially taking into account that they did not attempt to heat either the secondary or the primary air. Neither did they use steam under the producers, except the steam evaporated from the water in the ashpan. They had no difficulty in getting very good producer gas to any of the beds they were working off one producer. On the average, it came out to from 20 to 24 or 25 per cent. of carbon monoxide, and from 5 to 7 per cent. of carbon dioxide. It was seldom less than 17 per cent.; but at times it got up to 20 per cent. of carbon dioxide in the waste gases. The producers gave very good results; and these settings with external producers, being so extremely simple, were found to be far cheaper to erect than either generator or regenerator settings.

Mr. Wilson, in reply, said Mr. Anderson had referred to the size of the producers and the shape of them. The size was regulated by the difficulties in cleaning. They tried a larger producer, but there was more trouble in cleaning it. With the present size and shape, they could get at every part, and go down to clinker and ash. This would be more appreciated when he referred to the curtain. That point was also thought about; but it was no uncommon thing for them to have the producer filled more than half—five-eighths—with ash and clinker in 24 hours. If they put in a curtain of sufficient height to keep clear of the clinker, there would not be sufficient space for the coke to burn down between the draws. They therefore rather put up with the amount of dust going forward. The dust was certainly made when coke was being introduced; he did not think it was made when burning the fuel. The dust-chamber had got rid of most of the trouble. With regard to drying the retort-settings, they used practically the means that Mr. Anderson had described. They did not put the outside fires in the producers, but alongside the ovens, and saw that these and the settings were perfectly dry before starting work. As to the tabulation of the tests, he believed there was something in what Mr. Anderson said; but he just followed the usual method, as being more easy of comparison. As far as he was aware, there was very little trouble from leakage in the regenerators. The temperatures were all taken with a pyrometer which had been newly adjusted; but generally a certain amount of latitude had been allowed in these observations. In this particular case, it was quite possible that there might have been some leakage; but the simple regenerator they used kept very tight indeed. He must give the same answer to Mr. Brown's question as to Mr. Anderson's, Why did they not have one large producer? As to Mond gas, this came away at a low temperature; and all their results pointed to the benefit of having the gas from the producer at as high a temperature as possible. The first experiments showed this very clearly, because they could scarcely get enough coal carbonized to give coke for the producers. They lagged up the flues, to try and retain more of the heat. The loss by radiation did not exceed 4 per cent. of the total amount; and he did not think they could go much farther. With regard to steam-boilers, of course, steam must be used for this purpose; and in gas-works it did not bear quite the same ratio to the total expense as in most places, because they generally used up their refuse for fuel under the boilers, and it did not cost very much. Another point Mr. Anderson raised was putting the producers inside the retort-house. The main reason for having them outside at the beginning was to ensure regularity of working of the machinery in the house. It was therefore decided to locate them as shown on the plans. The height of the producers was regulated somewhat in the same way. If they had put in producers which were too deep, the small locomotives would not have been able to take the fuel up to them. Mr. Gibb had spoken about the cost for part of the work. Of course, they could not do the work so cheaply for a small section of the works as for a larger one, because the men required were so few, and one could scarcely halve a man when halving the work. They must have at least one man about a section of three producers, which was all that was wanted on a shift, except one man from time to time for clearing up at the bottom. The suggestion of a portable engine and a Roots blower was certainly a novel one; and he would not forget it. He was not aware, until Mr. Bell mentioned it, that Mr. Denny Lane had used outside producers. With regard to the regulation of the gas to the ovens, they had had no trouble with this since they had adopted the throttle-valve. The steam-blower was regulated by the pressure of the gas in the flues; and when one pressure was maintained, there was very little difficulty in keeping the heats regular. They were not dependent upon the pull in the ovens to the same extent as with ordinary producers. He assumed that Mr. Bell had no pressure in the flue, but depended entirely upon the chimney; but they had a pressure of about 1-10th in the flues at the ovens. The cost of the plant was £9 9s. per mouthpiece for the whole producer plant, including flues. This was in addition to the building of the settings.

Mr. A. F. Browne (Vauxhall) asked how the cost of these producers would compare with that of an ordinary regenerative process.

Mr. Wilson replied that he had not the figures; but in Glasgow they had two producers for every oven.

Mr. Bell asked if this included a spare one.

Mr. Wilson said it did not. With these producers they had practically no repairs at all, except cleaning them out Tests of the waste gases were made regularly; a certain number of ovens being taken every week. A point had been made which he quite expected when he saw Mr. Herring's paper; but there was no doubt about his figures being correct. There was quite as much difference between the cokes of the East and West of Scotland as there was between East Scotland and Newcastle coal. It was with great difficulty that they got 9300 or 9400 cubic feet of gas out of a ton of coal; while in Edinburgh they could get 10,500 feet. It was a different kind of coal altogether. In reply to a question, Mr. Wilson said that the grate area of the three producers was 99 square feet, or 33 square feet each. It came out practically ½ square foot per mouthpiece.

The Discussion on Mr. Bond's Institution Paper.—Mr. Bond asks us to correct the opening sentences in our report of his reply to the remarks on his paper as follows: "Mr. Bond said, in reply to Mr. Leather, that they had worked with a platinum and iridium couple and found it was not so constant as platinum and rhodium couple over a considerable time, as the electromotive force was sooner reduced in the former. As regards the freezing-point of aluminium, it was a very difficult matter to arrive at it exactly; but they employed to check the result the resistance pyrometer which Mr. Leather referred to." The last sentence of the reply should read: "They could by these fusing mixtures obtain temperatures within 10° C. of the correct result."

NEW GAS-WORKS FOR RENFREW.

As briefly mentioned in the "JOURNAL" last week, an important scheme of new gas-works for the Corporation of Renfrew was formally opened on Thursday, the 1st inst. The members of the Town Council, and a number of invited guests, assembled at the works, which they spent some time in inspecting. Thereafter the engine which drives the plant was started by Mr. Peter Ferguson. The following are a few particulars respecting the gas undertaking of the Corporation and its recent extensions.

The gas-works at Renfrew were built originally in the year 1840, and the output of gas steadily augmented, with but few extensions to the works until 1892, when the increased demands necessitated the construction of a new retort-house, exhauster, and a set of purifiers. The quantity of gas manufactured then was 13 million cubic feet, and the extension carried out was to be capable of dealing with 150,000 cubic feet daily, or 25 millions annually. From that year till 1902, the demand for gas rapidly grew with the population; and extensions were made from time to time to cope with it. At present it has reached 240,000 cubic feet daily, or 47 millions per annum. In 1898, the Town Council acquired a portion of ground immediately behind the original works—part of the public park. On part of this ground they erected a gasholder in the year 1899. About the same time the Glasgow and Renfrew District Railway Company were forming their new line through the park; and the Town Council, on seeing that the line would pass the south boundary of their ground, with the characteristic foresight which at all times wisely guides them in looking after the interests of the ratepayers, immediately negotiated with the Company; the result being the construction of a large retaining-wall 180 feet long by 17 feet in height, mutually between the Council and the Company. The new works just opened extend alongside the entire length of this wall; and the position lends itself to valuable facilities for the delivery and the despatch of gas-works materials.

The works consist of a retort-house 130 feet long by 27 feet high, having a clear span of 59 ft. 6 in. Within the house a retort-bench is constructed of eight ovens, each designed for eight retorts. Six of these ovens are fitted, and the remaining two will be put in to meet the requirements of the near future. The retorts are constructed on the stage-floor plan, and are on the full regenerative system, so as to carbonize the maximum of coal with the minimum of fuel in the furnaces. Each oven is fitted with a separate hydraulic main and tar take-off; every care having been exercised to safeguard the working results in this important department of gas manufacture. The hot coke is drawn from the retorts into hoppers, quenched, elevated by hoist, and either deposited into the store or screened and discharged into large hoppers for cart sales, or loaded into railway waggons for consignment. The coal-store is situated between the retort-house and the railway siding, is 130 feet long by 35 feet wide, and corresponds with the retort-house in height. The coal is received on the siding in waggons, which are carefully weighed and tipped up by hydraulic rams. The coal passes down a shoot into a hopper, thence to the coal-breakers, where all large pieces are reduced to the proper dimensions, and all under the stated size pass through a screen below the breaker. From this point the coal is conducted through an underground passage or tunnel on small side-tipping trucks running on rails, with a capacity of 22 cubic feet, equal to 10 cwt. of coal. The coal then ascends in a hoist worked by hydraulic pressure to a high-level 24-inch gauge railway, and is deposited in the coal-store or in hoppers above the stage level to suit the stokers' requirements. A series of shoots are constructed from the coal-store to the tunnel, which is a great advantage in wet weather, as dry coal can always be at hand, and elevated as required.

The condensers are of the annular type, and are located along the front of the retort-house. The engine-house is 28 ft. 6 in. by 14 ft. 6 in. and 14 feet high. The exhausting plant consists of two exhausters and engines combined, each capable of passing 25,000 cubic feet per hour. Here also is the duplex hydraulic pump and the engine for driving the washer-scrubber. Above the engine-house is a commodious mess-room for the workmen, including bath-room and lavatory accommodation. Access to these rooms is gained by a stair leading from the stage floor of the retort house. Adjoining these is the laboratory and photometer-room, to which access is gained by way of the lime-store. The purifier-house, which measures 84 ft. by 27 ft., has an arched elevation towards an unformed street. On a stage-floor are erected four purifiers 20 feet square, and immediately above is the lime-store. Shoots are provided in this floor for filling the purifiers, and on the stage-floor the spent material is conveyed through shoots to the bottom floor. The purifiers are of the luteless type, and the covers are made in one piece.

On the whole, the new works are of pleasing and substantial designs, consistent with economy; and they have been carried out to plans and specifications prepared by Mr. Thomas Lighbody, the Engineer. When the scheme was first submitted to the Town Council, they called in the services of Mr. A. Gillespie, of Glasgow to report on it. His report was to the effect that the scheme was the best that could be devised; and the Council are to be congratulated on the able manner in which the plans and specifications were prepared by their own Engineer. The new gas-works reflect the greatest credit alike on the Council, the Contractors, and the Engineer, for the very satisfactory manner in which they have been completed. Among the Contractors were the Barrowfield Iron-Works, Limited (retort-bench mountings), Messrs. Clapham Bros. (condensers), Messrs. R. Laidlaw and Son (exhausting plant), Messrs. J. & R. Houston (purifiers), and Messrs. Fullerton, Hodgart, and Barclay (hydraulic plant and coal and coke handling plant).

The Inaugural Ceremony.

At the close of the inspection, luncheon was served in the Municipal Buildings—Bailie Anderson presiding. Mr. J. Hepworth, of Edinburgh, in proposing the toast of "Success to the Gas Committee and to the New Works," said that Renfrew was fortunate in having at the head of its gas undertaking a man of great capacity. This was reflected in the new works, of which any community might be proud. Not a penny had been wasted upon them, and they were a credit to all concerned. The price of gas in Renfrew was 2s. 11d. per 1000 cubic feet of 23-candle gas; and in this respect the town excelled most others in Scotland. The works had not only been ably managed, but it was equally evident that there had been a careful nursing of capital in past days. Mr. Ferguson, in acknowledging the toast, said the new works had been completed at a cost of about £109,000, and were capable of enlargement to meet the demands of the burgh for a very long time. Moreover, they were so constructed that any extension could be carried out at very slight cost. The Engineer had been ably supported by the Contractors, who had carried out their work to the entire satisfaction of the Council, who would do their utmost to further reduce the price of gas. Bailie Brodie proposed "The North British Association of Gas Managers," to which Mr. J. W. Carmichael, of Barrhead, the President, responded. Mr. D. Macfie, of Edinburgh, proposed "The Royal Burgh of Renfrew;" and it was acknowledged by the Chairman. A silver coffee service was presented by the Contractors to the Chairman, for Provost Cumming, who was unavoidably absent. Mr. J. M'Gilchrist, of Dumbarton, closed the proceedings by proposing the health of the Chairman.

THE EFFICIENCY AND PRACTICAL IMPORTANCE OF COMMON SOURCES OF LIGHT.

By Professor W. WEDDING, of the Charlottenburg Technical College.

[Abstract Translation from the "Journal für Gasbeleuchtung."]

PART II.

(*Continued from p. 724.*)

Of two incandescent gas-burners, one ordinary and one inverted, affording equal spherical illuminating power, the inverted will obviously give more light on the work table, and hence must be considered the better. For such a comparison even the spherical illuminating power does not afford a really satisfactory criterion of the value of the light, in practical use, and still less is the "illuminating power," as ordinarily determined in the horizontal plane, of service. The lower hemispherical value affords a better basis of comparison; but even this fails to take into account the effect of the fittings and accessories on the distribution of the light. There can be no general rule for the comparison of all different types of burners and lamps. The Kramer inverted incandescent gas-burner was found to give a mean hemispherical illuminating power of 89·3 Hefners (78·3 candles) for a consumption of 3·2 cubic feet per hour. The specific consumption therefore shows a yield of 24·45 candles hemispherically per cubic foot of gas consumed, which is extremely good, and indicates the great advance in gas lighting which has been achieved. In respect of development of heat and carbonic acid, however, the electric light still remains superior to gas, especially for the lighting of separate work places, where the light is brought close to the worker. In regard to the instant switching on and off, which is one of the advantages of the electric light, many ingenious devices have been introduced to put gas on an equality with it; but so far no one of them has received general adoption. The small flame, with bye-pass, remains the usual plan.

Hitherto only the electric glow lamp with carbon filament has been used for lighting work places, and the Osmium and Nernst lamps can have only a limited application in this direction, for reasons which have already been partially indicated. The Nernst lamp has the disadvantage that it is not instantly lighted; and its destiny appears to lie in meeting the demand for a lamp of a power standing between the glow lamp and the arc lamp. It is necessary to bear in mind, when considering the lighting of a single work table, that the concentration of the light on a small area is only good up to a certain point. Just as the aim must be to provide a light approaching sunlight in colour, so must a room be uniformly lighted in imitation of the daylight condition. A sharp contrast between bright illumination and darkness must be avoided, because it is bad for the eyes.

LIGHTING OF SMALL LIVING ROOMS.

A somewhat stronger illumination is required in this case than for the lighting of a single work table. The lights suitable for the latter would have to be at least duplicated for the efficient

lighting of a small room, or, as an alternative, a more powerful light may be used, such as a 20 to 30 candle power petroleum lamp, or a 25 to 32 candle power electric glow lamp, or a Nernst lamp. The disadvantages of the evolution of heat and carbonic acid become more marked in this case, in which it is assumed that the room is kept shut up. Cost is in favour of petroleum and incandescent gas lighting. The Osmium, Nernst, and even the diminutive arc lamps may perhaps be successfully applied, though they are under considerable disabilities.

Lighting of Larger Living Rooms.

Here a further increase of illumination is required; and it may be secured by multiplying the numbers of the lights already considered. The *pros* and *cons* for the several sources are substantially as before. The diminutive arc lamps become practicable, because their fluctuations are of less moment where more than one lamp is employed. Whatever source of light is employed, the units should be many, or placed near the ceiling, so that the light is well distributed over the room. Persons using the room should not be subjected to the disagreeable effect of the heat radiated from a lamp owing to the latter being too low; while the sources also should be sufficiently far off to render the light in the room mild and soft. Common practice is still extremely faulty in this respect.

Lighting of Large Workshops.

In large workshops a better condition of things in regard to proper lighting frequently obtains. Outlay on this score is found to be recouped in the improved output of the hands. Electric lighting is common, because electric power is frequently used in the shops; but the Lucas and the various high-pressure gas-lamps are, in conjunction with the ordinary incandescent gas-burner, making headway in this direction. In schools and closed workshops, it is essential with these lights that adequate ventilation should be provided. The colour of the light may frequently be disregarded in the lighting of workshops, and hence it is the mercury vapour lamp, which gives a soft and well-distributed light, has been adopted in some instances in America, notwithstanding its dirty greyish-green and violet colour. In order to attain diffusion of the light, reflectors and shades are commonly used, and there is now a growing taste for indirect lighting, on which the Munich experiments* give much valuable information. The fact that the incandescent gas-burner emits more than half its light in the upper hemisphere, renders it peculiarly suitable for use for indirect lighting. With the arc electric lamp, on the other hand, the maximum light is emitted at an angle of about 45° below the horizontal, and if reflected upwards for indirect lighting considerable loss must occur, which loss rapidly increases owing to the deposition of dust on the reflector. Economically, however, the adoption of indirect lighting is a retrograde step, as the small proportion of the light utilized renders it very costly. But the fact that it is being adopted indicates that little regard is paid to the cost of good lighting, provided it fulfils the other requirements set forth above.

Lighting of Shops.

In the lighting of shops, reflectors are used to concentrate the light on a limited area. The use of a reflector with an inverted gas-burner consuming 4·18 cubic feet per hour afforded a maximum light below of 538 Hefners (472 candles), and an average of 421 Hefners (369 candles) over an angle 40° in extent. Opaque reflectors cannot be so freely used in shops as in rooms, because some general illumination is frequently required, and the use of translucent porcelain reflectors should then be resorted to. Two objects are aimed at in shop lighting; one being to attract the attention of the public by powerful window lighting, and the other to light the interior. Powerful lights, if used in the interior, must be screened from the direct gaze. Great advances have been made of late years in shop lighting.

Lighting of Streets, Squares, and Public Buildings.

Quite different principles apply in these cases to those already discussed in connection with the lighting of interiors. For the smaller and less frequented streets, all that is required is sufficient light to show the road and direction; but for the more important thoroughfares and squares of large towns, something better is decidedly desirable. The use of very powerful lights can only be practised to a certain extent with advantage, for they must be more or less screened, and then at least 20 per cent. of the light is at once wasted. The use of very high lamp standards entails a large outlay for installation and service, and the illumination of the ground by few but very powerful lights is very unequal. The distribution of the light from the source over the lower hemisphere has an important bearing on the fitness of any mode of lighting; and in this respect the continuous current arc is superior, with the inverted gas-burner as a close second. Both the upright incandescent gas-burner and the alternating current arc lamp require reflectors to make the greater part of their light, which is developed upwards, available. The steadiness and the colour of the light are not so important as with interior lighting, and the evolution of heat and carbonic acid have not to be regarded. Simplicity of service and cost are the two factors which weigh most in outside lighting, and on them an intense struggle has during the past two years been waged between the electric arc lamp and the high-pressure gas-burner. In regard to cost, the figures must vary for each place, and sometimes one and sometimes the other light would have the advantage. In some cases ulterior considerations will affect the choice, as when a local authority owns the gas or the electricity undertaking, and desires to utilize the municipal rather than a private supply.

In regard to gas lighting in the open, the author has, on a previous occasion, directed attention to the necessity for a proper consideration of the shape of the lanterns, and of the reflectors in particular. The object is not to concentrate the light on a spot immediately below the lantern, but to distribute it. Some light should even be dispersed above the horizontal plane; and this remark applies with special force to the lighting of very large interiors.

Conclusion.

The foregoing indicates that in no case can any general rules be promulgated as to lighting. Of the many modes of lighting, each has some advantages, and regard must be paid to the position and the conditions of the particular case. Lighting which is satisfactory in one place and under one set of conditions will often be impracticable elsewhere. It is wrong to take the absolute cost of the lighting as the sole basis for choice of illuminant, because incidental expenses may outweigh an advantage on this score. In any case there is now keen competition between the different modes of lighting; and it is to the public welfare that this competition should continue with full vigour.

* See "Journal," Vol. LXXXVII., p. 395.

THE FLOW OF GAS IN PIPES.

This subject has been under the consideration of a Committee of the Ohio Gas Association; and at the recent annual meeting the Chairman of the Committee (Mr. J. D. Shattuck, of Chester, Pa.), read a short report, in the course of which he stated that an attempt had been made to collect all the formulæ having reference to the flow of gas at high pressure, and that he had so far obtained the following:—

Pittsburg.

$$Q = 3450\sqrt{\frac{d^5\,(P_1^2 - P_2^2)}{l_f \text{ when } g = 0{\cdot}6}}$$

Coxe.

$$Q = 41{\cdot}3\sqrt{\frac{d^5\,(P_1^2 - P_2^2)}{L \text{ when } g = 0{\cdot}65}}$$

F. H. Oliphant.

$$Q = 42\sqrt{\frac{d^5}{L}(P_1^2 - P_2^2)}$$

Professor Robinson.

$$Q = 48{\cdot}4\sqrt{\frac{d^5}{L}(P_1 + P_2)\,(P_1 - P_2)\,\frac{0{\cdot}6}{g}}$$

Professor Robinson (more refined).

$$Q = 48{\cdot}4\sqrt{\frac{T_1}{T_2\,T_0}}\sqrt{\frac{d^5}{L}\,(p_1 + p_2 + 30)\,(p_1 - p_2\,\frac{0{\cdot}6}{g}}$$

W. C. Unwin.

$$Q = \frac{\pi}{4}\frac{P_1}{P_2}\,D^2 \times 468\sqrt{\frac{D}{c\,g\,l_f} \times \frac{P_1^2 - P_2^2}{P_1^2}} \times 3600$$

Richards.

$$Q = \sqrt{\frac{10{,}000\,d^5 c\,(P_1 - P_2)}{l_f}} \times 60 \text{ correct for gas } \sqrt{\frac{1}{g}}$$

Hiscox.

$$Q = c\sqrt{\frac{d^5\,(p_1 - p_2)}{w\,l_f}} \times 60$$

Professor Lowe.

$$Q = c\,\frac{p_2 + 14{\cdot}7}{14{\cdot}7}\sqrt{\frac{d^5\,(p_1 - p_2)}{0\,0761\,g\,l + \left(\frac{p_2 + 14{\cdot}7}{14{\cdot}7}\right)}}$$

Pitot Tube.

$$Q = 1690\,d^2\sqrt{h\left(1 + \frac{p}{15}\right)}$$

[In this formula, h is the difference in level between the two columns of water in the tubes, and p is the gauge reading.]

Velde.

$$P_1 - P_2 = 393{\cdot}7\left(\sqrt{1 + \frac{l_f\,g\,Q^2}{360{,}530{,}000\,d^5}} - 1\right)$$

The following designations are used in the formulæ given:—

Q = cubic feet delivered per hour.
P_1 = absolute initial pressure (14·7 + gauge pressure), pounds per square inch.
P_2 = absolute terminal pressure (14·7 + gauge pressure).
p_1 = gauge pressure initial, in pounds.
p_2 = " " terminal "
D = inside diameter of pipe in feet.
d = " " " in inches.
L = length in miles.
l = " yards.
l_f = " feet.
g = specific gravity, air = 1.
c = constant.
π = 3·1416.
T_0 = absolute temp. at max. density of water (461 + 37) 498° Fahr.
T_1 = " " of gas delivered (461 + deg. Fahr.)
T_2 = " " " flowing in main.

To correct the formulæ for any other specific gravity than that given above, multiply result by—

$$\sqrt{\frac{g \text{ in formula}}{\text{sp. gr. of gas.}}}$$

The author stated that the terms used in the formulæ had been given in an article supplied to the Revision Committee of the Association, containing a good many tables of the various constants used. He felt that a little more study of the subject would result in proving which was the best formula for the delivery of gas. On being asked by a member which one of the formulæ he thought approached the nearest to accuracy, Mr. Shattuck replied that in the article referred to he had given a synopsis which might answer the question a little more fully than the report.

Mr. Shattuck also explained that the formulæ had been derived from Dr. Pole's, and were more or less successful attempts to add corrections to it for density and coefficients of friction due to compression. The more complicated formulæ were simply attempts at greater refinement. He went on to say that it had come to be pretty generally understood that each sized pipe required a change in the formula to give its particular result. The coefficient of friction did not seem to vary with different densities of gas, but with each size of pipe. He had three cases the accuracy of measurement of which he did not know. At Newton (Mass.), a 6-inch line, 9600 feet long, 10 lbs. initial gauge pressure, and 9·28 lbs. final gauge pressure, delivered 18,200 cubic feet per hour; at Chester (Pa.), a 6-inch line, 7514 feet long, 27 lbs. initial pressure, 25½ lbs. final gauge pressure, delivered 20,100 cubic feet (but he was not satisfied with the accuracy of the measurement); and Mr. Oliphant said he checked his formula on delivering natural gas 100 miles into a gasholder through an 8-inch pipe. He had obtained the following results, taking the Newton condition:—

Pittsburg formula	18,380 cub. ft. per hour.
Coxe's	16,000 " " " "
Oliphant's	16,260 " " " "
Robinson's	18,730 " " " "
Unwin's	31,870 " " " "
Wehrle's	22,060 " " " "
Richards' (corrected for 0·6 gas)	18,708 " " " "
Hiscox's " "	16,250 " " " "
Lowe's " "	26,910 " " " "

In conclusion, Mr. Shattuck acknowledged his indebtedness to Dr. H. B. Harrop, of Milwaukee, for considerable assistance in obtaining several of the formulæ.

NORTHERN DISTRICT OF IRELAND GAS MANAGERS' ASSOCIATION.

The Second Meeting of this Association was held in Newtownards last Wednesday—Mr. W. J. ROBERTS, the Gas Engineer and Manager of the Newtownards Urban District Council, presiding.

The members of the Association having received a cordial welcome from Mr. J. M'Cutcheon, the Acting Chairman of the Council,

The PRESIDENT delivered an address. In the course of his remarks he said: Seeing that we have met in Newtownards, perhaps you will not feel disappointed if I place before you a few of the subjects which I have made my special study since I came here four years ago. I think I can say—and I am glad to be able to say—that in Newtownards we have fully shared the new lease of life upon which you all know the gas profession has entered within the last few years throughout the North of Ireland. We have found it necessary to practically renew the plant which formerly served to supply the town; and the desirability of this will be fully appreciated when I say that the estimated output for the year we are now in will be something like double what it was five years ago. You will remember that at our last meeting the Committee were instructed to make investigations with regard to the most profitable disposal of our tar. They have given the whole question their very careful consideration, and while they do not make what could be called a recommendation, they are of opinion that the prices now obtainable are so low that tar cannot be disposed of to better advantage than by burning it in the manner which I suggested at our last meeting.

Let me come now to a statement of the different points upon which I mean to touch lightly, and to offer to you for discussion, they are: (1) Increasing the consumption; (2) the purchasing of coal, with special reference to the question of slack; (3) returning washed gas to the hydraulic main with a view to retaining the rich hydrocarbons. I have found that one of the best means of accomplishing the first-named object is by the utilization of gas in engines. I have done my utmost to advocate this means of driving machinery, and I am glad to be able to say that eight or ten gas-engines have been installed in this town. I have also exerted myself to give all possible information and assistance to consumers, and to direct their attention to the real and substantial advantages to be derived from utilizing gas for cooking and heating purposes. When I came here first, the cooking-stove was a thing very little known—in fact, there were only some six or seven in the town; now there are upwards of 200.

To come to my second point; I found when I came here that the coal which was being delivered was really slack, with an odd lump here and there; but when the invoices arrived, they set out that the consignment was double-screened gas coal. Be this as it may, the coal, whatever its description, was, in my opinion, one of the finest gas coals brought into Ireland. But why should we be paying for double-screened coal and only receiving slack; or, as I put it to myself, why should we not pay for slack, and receive slack, at its proper price? Not being satisfied, I made a journey to the mouth of the pit, and discovered that it was really double-screened coal that was being shipped; but the handling of it, with its soft nature, reduced it to the slack which I received here. What was the result, however, of my visit to the markets when I sought to purchase slack as such? It was easier to think of than to procure, as the collieries that supplied the good gas coal had no slack for sale—at least at a price suitable for shipment. However, I can say that I have had between 35 and 40 different classes of slack; and the conclusion to which I have come is that slack can be profitably used in Ireland for the production of gas.

Coming now to my third subject—the retention of the rich hydrocarbons in the gas by means of returning a proportion of the washed gas to the hydraulic main—I based my assumptions more on the physical qualities of the gas than on any chemical action which might take place. I considered that the gas, practically from its leaving the retort, is supersaturated with both heavy and light hydrocarbons. The large percentage of heavy hydrocarbons retained in it at a high temperature makes it unequal to keep in more than a certain proportion of the light hydrocarbons. I formed the opinion that if we could reduce the percentage of heavy hydrocarbons in the gas there would, in all likelihood, be a larger percentage of light hydrocarbons retained. To effect this, I returned a certain proportion of the gas (which had already passed through the scrubber) to the hydraulic main. Seeing that the heavy hydrocarbons were removed from this gas, my theory was verified, there being a reduction in the percentage of heavy hydrocarbons. I may state that I have not the slightest doubt that I have by this process been able to obtain from 1 to 1½ candle power additional.

The remarks of the President were followed by a discussion, in the course of which Mr. J. Brodie, of Omagh, emphasized the necessity of gas managers looking after the interests of the consumers and keeping in touch with them. He said there were special facilities for doing this in Ireland, where, as a general rule, managers were given a free hand, and therefore could follow the gas after it had left the holder. Having a fitter in connection with the works was a good thing, as it tended to keep down complaints. He could not see how the President had obtained from slack the good results he had mentioned; but there they were. With regard to returning the gas to the hydraulic main, there was nothing new in this. It might be useful to the President, who was called upon to supply gas of high candle power for mill lighting; but he (Mr. Brodie) hoped to see him joining the ranks of the advocates of low candle power, and the mill-owners using incandescent burners, which could be employed with perfect safety in woollen and flax mills. Mr. T. Frizelle (Holywood), while acknowledging that the President had obtained good results from his slack, said that he could get 2000 or 3000 cubic feet more gas out of screened than unscreened coal; also more ammonia, as much tar, and a purer coke. The last was a great point. Mr. R. Harrison (Monaghan) said he had tried an experiment with slack, but it gave rise to so much dissatisfaction among the stokers that he would not repeat it. Slack did not suit them at Monaghan. Mr. B. Mitchell (Bangor) said he did not think he could use slack in his works. Moreover, he had always obtained good results from double-screened coal. The President briefly replied to the different speakers; and the proceedings closed.

The Council of the Society of Arts have awarded the Albert Medal of the Society for the present year, with the approval of His Royal Highness the President, to Lord Rayleigh, O.M., D.Sc., F.R.S., "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, among other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea." Lord Rayleigh, as our readers may remember, is Chief Gas Examiner for the Metropolis, and was Chairman of the Departmental Committee on Gas-Testing.

REGISTER OF PATENTS.

Purification of Coal Gas.—Roux, X., of Paris, Gonin, B. W., of Uxbridge Road, W., and Thompson, W., of Great Winchester Street, E.C. No. 13,377; June 13, 1904.

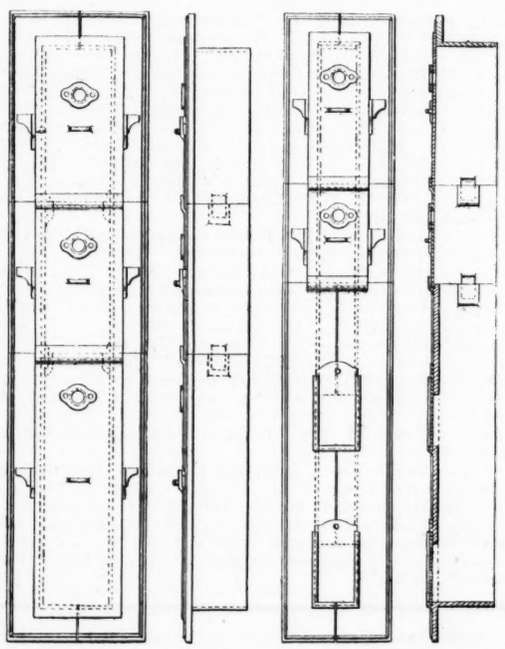
This invention has for its object the removing of ammonia, sulphuretted hydrogen, and the like from gases during the process of manufacture and their absorption in peat "to form a valuable nitrogenized manure or fertilizing substance."

In one way of carrying out the invention—after the gas has passed the usual condensation apparatus—it is led through, or in contact with, granular or lumpy peat that has been treated with a solution of an alkali and dried; and this treatment of the prepared peat with ammonia converts it into nitrogenized manure. Suitable peat is reduced to powder, and in accordance with its power of absorption is treated with a solution of any alkali whatever, which solution contains the alkali from, say, 2 to 12 per cent. The peat is then dried, and introduced into baskets of meshed wire; a number of the baskets being arranged in a casing through which the gas is passed.

Doors and Frames for the Flues of Gas-Retort Settings.—Bell, J. F., of Derby, and Masters, R., of Bedford. No. 13,409; June 14, 1904.

This invention has reference to flue doors and frames that are subjected to considerable heat, which (with the movements of the brickwork) is liable to crack the flue door-frames.

The complete door-frame shown is of rectangular form, made in two or more parts—say, for instance, four parts—of which there will be two L-shaped parts each of which forms a portion of one side and a portion of the bottom of the frame, and two inverted L-shaped parts which form the remaining portions of the two sides and the top of the frame. The upper or intermediate side portions of the frame are made with downwardly projecting parts or spigots on their lower ends which take into corresponding sockets or snugs formed on the sides of the adjacent parts below; thus keeping the sections of the frame together and in place. When the parts of the frame are fitted together, they form the complete rectangular flue door-frame; and owing to the fact that they will give at the joints, the frame accommodates itself to expansion and contraction and the movements of the brickwork.



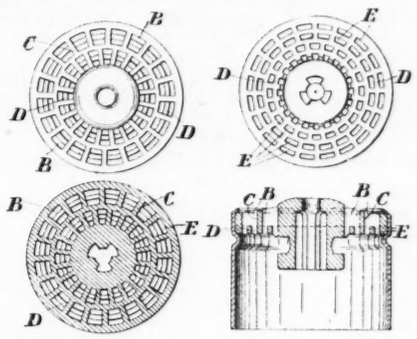
The frame made as described is fitted with one or more flue-doors, each having side projections which take into slotted lugs cast or fixed to the sides of the frame, so as to keep the doors in place and permit of any flue-door being removed from the frame and replaced when required.

When the frame is a long one and is fitted with more than one flue-door, the doors are arranged in a row one above another; the upper edge of each door, except the top one, having a rebated upwardly projecting ledge in which fits the bottom of the next flue-door above. As each door is independently supported from the frame by the side projections, any door can be removed for inspection of the flue without removing the others.

The L-shaped castings forming the four corners and portions of the top and bottom and sides of the frame can be heightened by employing between them two or more intermediate side-pieces, which fit in between the sides of the corner castings and make up the frame to the desired height—each pair of intermediate side-pieces being fitted with a door of corresponding height, so as to fit in between the other flue-doors of the frame and make a complete frame and doors.

Burners for Incandescent Lighting.—Bray, J. W., of Leeds. No. 15,001; July 5, 1904.

This invention refers to a tip for incandescent burners having a series of orifices for the escape of the gas and a screen made integral with the burner. It is a modification of patent No. 5215 of 1903, the specification of which stated that, in order to prevent lighting-back, wire gauze of suitable mesh should be inserted immediately below, and in contact with, the burner head or tip. Wire gauze, however, is liable to corrode, and also to have dust and other moving particles adhere to it, and thus cause lighting-back. The improved burner head or tip is constructed entirely of non-corrosive material, such as "potter's clay." The desired form is given to the tip by stamping or moulding in presses; but if steatite is used, the requisite form may be given to the tip by turning and drilling or other convenient shaping processes.



Concentric circles of orifices B are made in the top layer C of the tip—by preference substantially rectilineal. If there be two concentric circles of orifices in the top layer as shown, there are formed in the bottom layer D four circles of smaller orifices E, to take the place of the metallic wire gauze hitherto used.

In order to support the mantle-rod, a hole is formed in the centre of the tip, and grooves are made in the walls of the hole for the purpose of carrying a clip such as is described in the 1903 patent. The tip, of non-corrosive material, may be mounted in a socket or tube of metal, and be detachable from the burner.

Where the concentric layers C and D of the vertical orifices are in two separate plates, as shown by the dotted line in the section, the two are mounted together in one tube or socket, and confined in juxtaposition by flanging or spinning suitable projections in the metal of the tube.

Coin-Receiving Device for Prepayment Sale and Delivery Mechanism for the Sale of Gas.—Hawkyard, J., of Uppermill, and Meters Limited, of Manchester. No. 15,652; July 14, 1904.

This invention of mechanism used to receive a coin which is prepaid and to utilize it to secure the delivery of a predetermined volume of gas, has for its object to so construct the coin receiving and operating mechanism as to enable the extent of the stroke of the coin-receiver to be varied or adjusted at will, in order to permit of the delivery of a varying volume of gas in exchange for a coin of any fixed value.

A circular case A (p. 838) is attached to the meter case, and there is fixed to it a frame B containing the mechanism by which the supplementary gas-valve can be opened or closed to ensure the delivery of the predetermined volume of gas. Near the lower end of the circular case is an internal flange forming an annular bearing surface on which the edge of each coin, after it has been inserted in the case, rests while it is being carried round by the coin-receiver. The flange also acts as a bearing surface on which a toothed ring or annulus C rests—fitting freely in the case so as to be easily rotated. The annulus is provided on its inner edge with teeth of equal pitch. On its upper edge is a second set of teeth with which a small pinion D engages. The pinion is fastened to the end of a spindle or shaft E, connected to, and gearing with, the gas-delivery portion of the mechanism—the spindle being carried by suitable bearings.

One end of the case A is covered by a lid F having a slit cut in it and formed with a flange which fits over the case. In the edge of the flange are cut accurately and equally spaced notches G. When the cover F is pushed into position, one of the notches fits over a tongue or slip H fastened to the case of the coin-receiver mechanism at a suitable point. The spindle K is formed with a central boss, which is riveted to the disc M, or (if desired) it can be cast in one piece with the disc. The other end of the spindle is carried by a suitable bearing formed in a bridge-piece V attached to the case A. To the spindle K is attached a lower disc N, to which is fixed the coin-receiver O. The spindle projects through the cover F and upper disc M to permit a handle to be fixed on it outside the case—thus enabling it to be rotated from outside.

Slits are cut in the faces of the upper disc M and cover F respectively, to enable a coin to be inserted into the coin-receiver O. Projecting inwardly from the cover F (at a point closely adjoining the coin slit) is a stop P, which, when the coin-receiver is pressed against it, causes the slit in the receiver and the slit in the upper disc M to be in register with the slit in the cover F. At another point, there is fastened to the frame of the device a fixed stop R, which limits the travel of the coin-receiver in its movement after the coin has been inserted. When the cover F has been adjusted in the desired position, it is fixed, by screwing the spindle K on the portion which extends through the bridge-piece V and employing a nut, or else the portion of the spindle has inserted in it a screw S as shown. Part of the spindle passes through the case into the space in which the money-box is; and as the latter is secured by a lock or seal, the position of the cover F cannot easily be tampered with.

When the coin is inserted in the slit of the disc M and in the slit of the cover F, it falls partly into the receiver O and partly between two of the teeth on the inner surface of the annulus C; forming a connection between them. The annulus is therefore rotated through the same angle as the coin-receiver, and as it gears with the pinion D, it rotates the shaft or spindle E in connection with the delivery mechanism—the latter being thus moved to a proportionate extent.

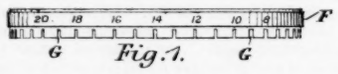


Fig. 1.

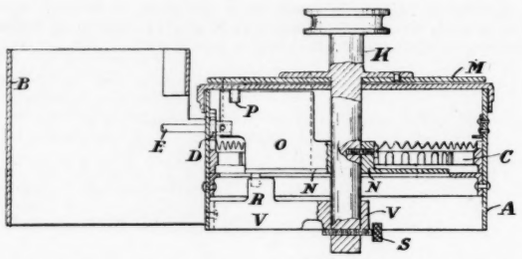


Fig. 2.

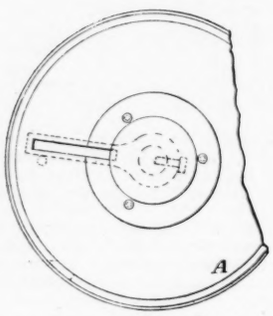


Fig. 3.

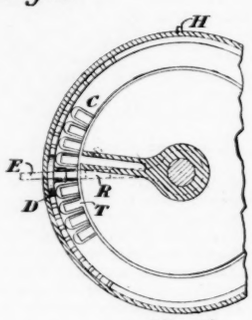
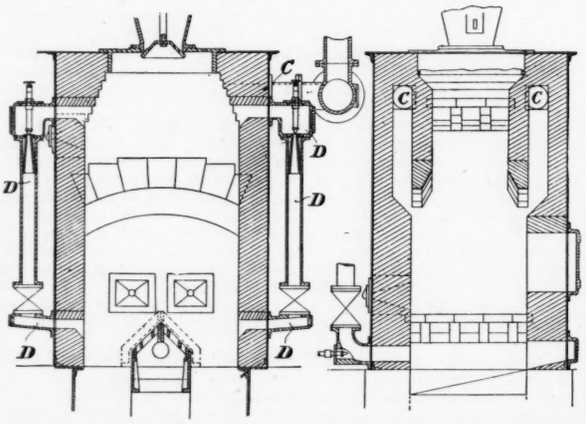


Fig. 4.

Each of the notches G in the cover F represents the delivery of an equal and predetermined number of cubic feet of gas—more or less; and the number of feet delivered after the insertion of a coin depends upon the relative position of the notch engaging with the tongue or slip H. In order to facilitate setting, the number of cubic feet of gas which will be delivered when any particular notch is in position can be indicated by figures stamped or attached above the notch as shown. At a given point (preferably adjoining the fixed stop R) a gap T is cut in the flange sustaining the coin while the toothed annulus C is rotated by it, so that at that point it can fall into the money-box.

Manufacturing Producer and Water Gas.—Mason, W. F., of Manchester, No. 15,821; July 16, 1904.

This invention has for its object "the construction of apparatus of simple formation, which is yet capable of producing a comparatively pure gas." The main portion of the apparatus employed is rectangular or in circular form as heretofore, and with an internal grate of any suitable kind, although the patentee prefers to make use of the class of grate described in Duff's patent No. 7467 of 1893.



Above the level of the upper surface of the fuel being burnt within the producer is formed an opening or openings C for the final emission of the gas, and leading to one main outlet pipe. The chambers within the producer leading to the openings are partially cut off from the main portion of the interior of the apparatus which is in communication with the feeding hopper or other contrivance, by means of walls or divisions of fire-brick—that is to say, the lower portions of the spaces referred to are not closed in, or the side chamber dividing walls merely extend somewhat below the top level of the fuel being burnt. The internal space or spaces or chambers thus formed are said to largely prevent the escape of the gases into the pipes C, except after properly passing through the incandescent fuel below, through which fuel the gases are circulated by a circulating pipe or pipes D in communication with the main body of the apparatus. Thus, by the means described, it is possible to utilize openings for the emission of the gas of considerable area, and yet largely prevent "the hydrocarbons which are given off by the burning fuel in the first instance from making their final outlet until the desired decomposition has taken place in order to form a purer gas or one richer in carbon monoxide." Added to this, the side emission openings enable the pipes connected with them to be easily and effectively kept free from deposits; thereby reducing the possibility of tar and other impurities being carried over by the gas as it passes through such emission openings.

APPLICATIONS FOR LETTERS PATENT.

10,632.—Lane, H., "Gas-producers." May 22.
10,667.—Pennifold, A. V., "Gas-taps." May 22.
10,685.—Lake, H. H., "Kindling gas-jets." A communication from the "Rapid" Elektrogasfernzunderwerke G. m. b. H. May 22.
10,688.—Brooks, F. M., "Incandescent lamps." May 22.
10,706.—Fichet, A., and Heurtey, R., "Gas-producer." May 22.
10,721.—Beasley, C. H., "Gas-calorimeter." May 23.
10,725.—Helps, G., "Gas fittings and burners." May 23.
10,733.—Hooton, R., and Noble, J., "Production or enriching of gas." May 23.
10,739.—Carnegie, D., "Notifying pressure changes." May 23.
10,882.—Gitenet, M. A., "Incandescent burners." May 24.
10,898.—Piper, E. J., "Meter." May 24.
10,954.—Woodall, H. W., and Duckham, A. M'D., "Vertical or inclined retorts." May 25.
10,971.—Morris, F. H. G., "Purifier grids." May 25.
10,980.—Ferris, W., "Meters." May 25.
10,993.—Towns, W., "Purifiers." May 26.
11,010.—Norris, C. G., and Bentley, G. H., "Gas-cleaning plant." May 26.
11,011.—Norris, C. G., and Bentley, G. H., "Gas-producer." May 26.
11,041.—Jackson, J. D., "Gas-burner." May 26.
11,042.—Jackson, J. D., "Water-heaters." May 26.
11,043.—Stern, G. B., and Greene, A. C., "Flexible gas-piping." May 26.
11,059.—Pilgrim, R., "Acetylene-generators." May 26.
11,071.—Glover, T., "Water-heater." May 26.
11,083.—Tatters, H. L., "Gas-calorimeter." May 27.
11,087.—Jennings, J., "Gas-fittings." May 27.
11,103.—Ballinger, T., and Kirk, T., "Gas-cocks." May 27.
11,132.—Amendt, H. C. T., "Gas-cookers." May 27.
11,133.—Williams, P. F., "Gas-cookers." May 27.
11,148.—Noad, A. C., "Gas-lamps." May 29.
11,164.—O'Connor, H., "Prepayment meters." May 29.
11,174.—Morris, F. H. G., "Clearing pipes and mains." May 29.
11,242.—Bingham, C., "Acetylene-burner." May 30.
11,245.—Smith, T. B., and the Sunlight and Safety Lamp Company, Ltd., "Hanging gas-lamps." May 30.
11,250.—Williams, J. T., "Incandescent burners." May 30.
11,266.—Sanderson, H., "Mantle support." May 30.
11,323.—Lake, H. H., "Gas-burners." A communication from B. F. Jackson. May 30.
11,349.—Hirschhorn, J., "Ribbed radiator tubes." May 30.
11,350.—Hirschhorn, J., "Gas-heater." May 30.
11,372.—Hills, H. G., "Gas making." May 31.
11,373.—Hills, H. G., "Gas enrichment." May 31.
11,413.—Assmann, O., "Compressed gas for power." May 31.
11,429.—Gill, H. V., "Gas-burners." May 31.
11,450.—Petitpierre, C., "Meters." May 31.
11,560.—Darby, H. W. & I., "Burners." June 2.
11,566.—Beal, W., "Inverted incandescent gas-lights." June 2.
11,596.—Gateau, F., and Deschamps, E., "Ignition of gas." June 2.
11,619.—Davis, H. N., "Combined gas and coal fire ranges." June 2.
11,642.—Lever Bros., Ltd., and Cook, W., "Repair of leakages in tubes." June 3.
11,657.—Hutchins, T. W. S., "Gas-producer." June 3.
11,675.—Chambers, R. M. & C. E., and Crawford, R., "Regulating the supply of gas produced by the suction process." June 3.
11,687.—Gow, J., and the Gas-Meter Company, Ltd., "Coin-freed meters." June 3.

Selby Gas Supply.—In his annual working statement, Mr. T. H. Alderson, the Engineer and Manager of the Selby Gas-Works, states that there was a gross profit of £3038 on the past year's operations. The make of gas (41,513,800 cubic feet) showed an increase of 7·13 per cent. over the previous year; while the unaccounted-for percentage was 2·72, as compared with 2·81. The make per ton also increased from 10,855 to 11,012 cubic feet. From the profit realized, the sum of £714 has been deducted as the proportion of the cost of the Urban District Council Bill chargeable to the gas revenue account, and £200 has been set aside towards the creation of a reserve fund.

The Loss on the Dukinfield Gas-Works.—It was agreed at a meeting of the Dukinfield Town Council last week that several drastic changes should take place in the management of the gas-works, which on last year's working recorded a loss of £166, against a profit the previous year of £1470. The intended changes are that Mr. Harrison Veevers, the Engineer and Manager, should be allowed a salary of £120 per annum as Consulting Engineer, and that the clerical staff should be reduced. Mr. Bowden, the Chairman of the Gas Committee, said the year's loss was not so bad as would at first appear; for the Committee had reduced the price of gas 2d. per 1000 cubic feet, which meant a reduction of £600 in the income.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Plain v. Pleasing Retort-Houses.

SIR,—I much regret that I was unavoidably prevented from being present at the Institution meeting when Mr. W. Doig Gibb's "Notes on Structural Engineering" were read and discussed. For I find that he has done me honour, though quite anonymously, to refer to a statement in a paper I read four years ago, on "Some Differences between British and Continental Gas Engineering;" and I should have been glad to have had the opportunity of supporting what I then said, and of refuting the misleading strictures that Mr. Gibb has seen fit to place upon it. May I therefore beg you to allow me a short space to put in writing what I wished to put in words?

Although it is generally objectionable to quote oneself, the essential statement of my paper was this: "It is surely better to build a retort-house both beautiful and practical than one that is the latter only. The utility of an article is no excuse for its ugliness. Expense, fortunately, does not enter into the question at all; for *a pleasing building need not cost any more than a plain one*, and even if it did, something would have to be set apart for moral and intellectual considerations."

The phrase in italics is the one of which Mr. Gibb says in his paper, "it is not easy to understand." Why not? It is surely a perfectly simple, straightforward, and self-evident statement, which one would have thought there would have been no difficulty in understanding. "A pleasing building need not cost any more than a plain one" means simply this—that, given the same sum, and the same quantity of material, one engineer, by judicious choice of design and well-advised use of material, will get a pleasing building, whereas another will obtain only a plain or ugly one.

To take a homely illustration. I can go into the street and buy an artistic toy for a penny; I can also go into the street and buy an ugly toy for a penny. One engineer, having (say) £5000 to spend on a retort-house, can obtain an artistic and pleasing result; another engineer, having the same amount of money to spend on the same sized house, will obtain an inartistic and ugly result. My plea was, and is (and I am glad to have the distinguished support of Mr. Charles Hawksley) for the pleasing in preference to the plain building.

But Mr. Gibb says—altogether unwarrantedly, in my opinion—that "the opposite of 'plain' is 'elaborate';" and he then proceeds, on an absolutely arbitrary and unjustifiable supposition, to say that "if 'pleasing' means 'elaborate,' it is usual to amplify the description, 'a pleasing building,' by inserting the words 'but unnecessarily costly.'" Now, I made it quite clear that my antithesis to "plain" was "pleasing," and why anyone should desire to drag in "elaborate," and make it synonymous with "pleasing," which it most certainly is not, I am at a loss to understand. To define your opponent's terms in an abnormal way, and then to build up an argument upon such gratuitously misleading interpretations, is indeed to erect a flimsy structure on a false foundation.

Were one to judge Mr. Gibb's æsthetic sense from his paper only, it might not be unreasonable to agree with his statement that he is "probably deficient in his appreciation of art;" for he does not conceive it possible for a gas-works to be a thing of beauty, and he also seems to have some idea that "unnecessary ornament" has some connection with the beautiful in gas-works. Of course, neither of these propositions is true; and had Mr. Gibb done me the honour of reading my reply to the discussion on my paper, he would have seen that I said: "I do not plead for ornamentation at all," but "we might avoid what is grossly utilitarian and ugly, and strive after simpler, and therefore more artistic, effect."

But, fortunately, we need not take Mr. Gibb's loose words. We have his own admirable works to speak for themselves; and from my pleasurable recollection of a visit to Newcastle, I am quite content to rely upon them as an effective illustration of my argument. Then I am also reminded of the Tunbridge Wells Gas-Works, as another example; and I find that the description of them given in the "JOURNAL" for Dec. 23, 1879, uses, curiously enough, the very word I adopted, and says, "their general effect is very *pleasing*." A later "JOURNAL" records a reference to the fact that Mr. Spice was the "designer of these *beautiful* gas-works." A last illustration, among many in hand, may I think (judging from photographs, for I have not had the pleasure of visiting the works themselves) be obtained by citing the pleasing retort-house at what Mr. Gibb himself described as the "magnificent new gas-works" at Glyne Gap. I would also like to draw Mr. Gibb's attention to the fact that the three illustrations I have given are works which belong not to corporations, but to companies, which I suppose are "run on commercial lines."

May I, lastly, just refer to the "moral and intellectual considerations," from my mentioning which, Mr. Doig Gibb seems to draw the strange deduction that I was not quite sure of the soundness of my first statement in the passage quoted. But why the fact that a person has two good reasons instead of one, should weaken, instead of strengthen, his belief, I do not see. What I maintain is that stokers and others working in pleasing retort-houses—with baths, mess-rooms, and other comforts—among clean, orderly, and healthy surroundings, are likely to be more efficient and valuable servants than are those struggling in ugly and ill-designed houses, among dirty, disorderly, and insanitary conditions. I do emphatically say that such moral and intellectual considerations should not be lost sight of in designing pleasing retort-houses in beautiful gas-works.

C. E. BRACKENBURY.

June 8, 1905.

The Carnarvon Town Council have considered a scheme submitted by the Gas Manager (Mr. W. M. Ruxton) for the extension of the gas-mains in various parts of the borough, and have decided to apply to the Local Government Board for power to borrow £2000 for the purpose.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

The following further progress had been made with Bills down to the rising of the House for the Whitsuntide recess:—

Bill brought from the Commons, read the first time, and referred to the Examiners: Bootle Corporation Bill.

Bills read a second time and committed: Local Government Provisional Order (Gas) Bill, and Rhondda Urban District Council Bill.

Bills reported: Gas Orders Confirmation Bill, Gas and Water Orders Confirmation Bill (No. 1), Halifax Corporation Bill, and Local Government Provisional Order (Gas) Bill.

Bills read the third time and passed: Birmingham Corporation Bill, Blackpool Improvement Bill, Gas Orders Confirmation Bill, Shepton Mallet Gas Company (Electric Lighting) Bill, Southport, Birkdale, and West Lancashire Water Board Bill, and Stockport Corporation Bill.

The Andover Lighting and Power Bill and the Heckmondwike Improvement Bill have been referred to a Select Committee, consisting of the Earl of Lauderdale (Chairman), Earl Temple, Lord Crofton, Lord Congleton, and Lord Rosmead; to meet on the 29th inst.

HOUSE OF COMMONS.

The following further progress had been made with Bills down to the rising of the House for the Whitsuntide recess:—

Lords Bills read the first time and referred to the Examiners: Blackpool Improvement Bill, Llandrindod Wells Urban District Council Bill, Matlock Bath Improvement Bill, and Southport, Birkdale, and West Lancashire Water Board Bill.

Lords Bills read a second time and committed: Hythe Corporation Bill, Mansfield Corporation Bill, Nottingham Corporation Bill, Tees Valley Water Board Bill, Western Valleys (Mon.) Water and Gas Bill, and Whitby Urban District Council Bill.

Bill read the third time: Bootle Corporation Bill.

LONDON GAS BILL.

House of Lords Committee—Monday, June 5.

(*Before the Earl of* ROSSE, *Chairman, Duke of* WELLINGTON, *Marquis of* WINCHESTER, *Earl of* GAINSBOROUGH, *and Lord* MOSTYN.)

The proceedings on this Bill, which were commenced on the 2nd inst. (*ante*, p. 724), were continued to-day.

Sir RALPH LITTLER, K.C., Mr. FREEMAN, K.C., and Mr. TALBOT appeared for the promoters, the London County Council. The opponents of the Bill were the three London Gas Companies—the Gaslight and Coke Company and the Commercial Gas Company being represented by Mr. BALFOUR BROWNE, K.C., and Mr. BERNARD WILKINSON, and the South Metropolitan Gas Company by the first-named learned Counsel in association with Lord ROBERT CECIL, K.C., and Mr. ROSTRON.

SIR GEORGE LIVESEY FURTHER CROSS-EXAMINED.

In answer to Sir RALPH LITTLER, witness said he had the fullest opportunity of expressing his views before the Departmental Committee, the original object of which was to deal with the question under consideration, but only partially. The reference was made as wide as possible.

Sir RALPH LITTLER: The County Council have given effect to everything with regard to the purity of gas, though their view was that it was undesirable to conserve the existing state of things?

Witness: They did not accept the recommendation of the Departmental Committee in its entirety in the Commons.

Has this Bill given effect to the purity portion?—Yes.

Therefore you got your way on one point, and you desire that effect shall be given to that?—Yes; I think we proved our case completely before the Committee.

You desire to give effect to the decision which was given in your favour, and abrogate the decision which was against you?—We say we have learnt a great deal about gas testing since the Departmental Committee sat. We say this recommendation of the Committee is proved to be absolutely wrong.

Do you know that the "London" argand burner is used with a fixed consumption of 5 cubic feet, exactly as suggested in the Bill, by a great many provincial companies?—Yes; and I know that provincial tests are merely nominal tests.

That is the parliamentary obligation?—Yes.

There are two with only 10-candle power which are tested by the same method?—I say that it is impossible to test 10-candle gas by this method.

As I understand, your ideal condition is no restriction as to candle power?—No; I do not ask that. I say that, considering the altered circumstances of the gas industry, we are now exposed to the fiercest competition. If all restrictions as to illuminating power were abolished, we should have to supply consumers with the quality of gas which would satisfy them.

That is the point you make—that you would like to be free?—Gas companies were free for forty years.

You would like to be free now?—Yes.

Do you know that Manchester is free?—Yes.

They supply a light of 15¼-candle power?—Yes.

Nottingham supplies gas of 18-candle power?—Yes; but Nottingham does not test at the 5-feet rate.

Do you know that Bath, where the statutory power is 14 candles supplies gas of 16-candle power; and though it is an inland town, with no coal supply worth speaking of, the price is 2s. 3d. per 1000 cubic feet?—I satisfied the Committee in 1900 that all enrichment would be a mistake, and that what the industry wants now is a cheap supply of gas of low illuminating power.

Do you know that in 1900 the question of the method of testing was hardly discussed in one House, and not discussed at all in the other?—The mode of testing was the accepted mode at the time, as applied by the Referees and adopted in London.

Re-Examined by Mr. Balfour Browne.

In re-examination by Mr. Balfour Browne, witness said that they only proposed to put into the Act of 1900 the mode of testing current in London at the time. The reduction of illuminating power which was proposed in the same Act, was most violently contested, and the Company proved it would be better for the consumers to have a lower illuminating power and cheaper gas, than a higher illuminating power and a dearer gas. All the Company wanted now was to have a proper test of the quality of the gas. He did not think that burning all gases under the same conditions did justice to those of low illuminating power. The test proposed in the present Bill would be about right for the Gaslight and Coke Company's gas, if it was a 16-candle coal gas; but it, was certainly not a fair test for a coal gas of 14 candles, such as his Company were supplying. A 10-candle gas could not be tested by this method. Professor Frankland had stated that at 17-candle power the test was no use at all; so it was only within certain narrow limits that it was effective. If this test was imposed upon his Company, they would have to produce a higher quality of gas, in order to escape penalties, than they had done in the past; and this would make the consumer pay more for his gas. Their whole object was to increase the consumption of gas by making it as cheap as possible; and this test would make it dearer. He believed that no evidence was laid before the Departmental Committee as to the result of experiments with gases of low illuminating power under the conditions proposed by the Bill. With regard to the three days' average, this would not be a help to the South Metropolitan Company, because they did not enrich. If they made partly water gas and partly coal gas, as the other two Companies did, it would be different; but the South Metropolitan Company only supplied coal gas, and had no means of enriching. It would, however, enable the Company to avoid any penalty for a mere accident. It is a very fair proposal, and was suggested by the Committee of the House of Commons, he believed, as a sort of compensation.

Mr. Balfour Browne: My friend mentioned several places where this test was applied; and on Friday you named other places where the test has not been applied?

Witness: Yes.

You know that at Wandsworth, Rochester, and Brentford there is a special burner?—Yes; for 14-candle gas.

A special burner makes the test fair?—Yes; but I think the Committee were right in recommending one standard burner.

If you had that, you would have to alter the feet per hour?—Yes.

Further Evidence for the Companies.

Mr. *W. J. Dibdin*, examined by Mr. Rostron, said that in 1876 he was appointed one of the Gas Examiners to the Metropolitan Board of Works, and continued to hold that office till 1882. He produced the table and diagram which were put in before the Committee of the House of Commons, giving the results of a series of experiments with different gases tested under the South Metropolitan Company's system and that proposed by the Bill, which showed the gases of low illuminating power suffered great disadvantage under the latter method.*

Dr. *S. Rideal*, answering Mr. Rostron, said that since the Bill was in the House of Commons he had carried out two series of experiments to find the difference between the existing legal method of testing gas and that proposed by the Bill. They were made upon the gas actually being supplied by the South Metropolitan Company at the official testing-station. He handed in a table showing the result of these tests, and stated that the average difference came to 1·6-candle power. The general result of the experiments was to show that the candle allowance was not a fair one; that, as a rule, it was more than a candle, and that consequently there would be continual friction between the County Council and the Gas Companies. Taking the fortnight's testing, or eight out of eleven days, there would have been a dispute between the two parties. The Company would be compelled, therefore, to raise the quality of the gas they were supplying.

In cross-examination by Sir Ralph Littler, witness said he made one test on each of the days, but the prescribed test was four. Therefore the average for three days was twelve tests, whereas his was only of three.

Professor *Vivian B. Lewes* said, in answer to Mr. Balfour Browne, that the first part of clause 4 described the method of testing gas which had been recommended by the Departmental Committee, which, in his view, was absolutely erroneous. When one tried to adopt a constant rate of flow, one found at once that, by using the "London" argand burner, one got wider discrepancies introduced. The "London" argand was originally made for burning pure coal gas of about 16 candles; and for this it was perfectly fitted. When one came to burn a gas having only the fraction of a candle less illuminating power, the result was an injury to the gas, exaggerating the defects. This was so thoroughly recognized in the nineties that the Board of Trade appointed a Committee, which was probably the best that ever sat upon the subject of photometric measurements. The three Gas Referees were members of it, and also the Chairmen of the three Gas Companies, and the Chief Gas Examiner for the Corporation. The result of the investigation, which lasted from 1892 to 1894, was that they abolished the testing of the gas at the rate of 5 cubic feet an hour, and introduced the method which was now adopted in London—viz., that one burnt the gas until a light of 16 candles was obtained, and then deduced from the amount of gas burnt what the candle power would have been at the rate of 5 feet. This was not the best method of testing, but it was fair as between the seller and consumer of gas. The plan proposed by the Bill was absolutely inaccurate. He thought a great deal of the trouble had been introduced by dealing with two separate issues—the price of gas and the candle power. If they were to have a determination of the candle power, he was very strongly of opinion that the candle power as determined should be the candle power of the gas; and then the price should be kept as a separate thing. There would be very little to be said against the method of testing if every gas was depreciated in the same proportion. But uniformity was impossible; and it was because of this that it was not an accurate test. The 5 feet an hour rate was abandoned, and was not now in use at any station in London.

* See "Journal" for March 21, p. 781.

Table I.—Handed in by Dr. Rideal.

Date, 1905.	I. 16-Candle. (Size of Chimney, $1\frac{3}{8}$ in.)	II. 5 Cubic Feet. (Size of Chimney, $1\frac{7}{8}$ in.)	Difference between I. and II.
April 3	14·4	13·1	1·3
,, 4	14·4	12·9	1·5
,, 5	14·9	14·5	0·4
,, 6	14·2	13·2	1·0
,, 7	14·3	13·3	1·0
,, 8	14·4	12·4	2·0
,, 10	15·0	13·8	1·2
,, 11	14·7	13·7	1·0
,, 12	15·4	14·1	1·3
,, 13	14·8	14·2	0·6
,, 14	14·9	12·6	2·3
,, 15	14·7	13·4	1·3
Average	14·7	..	..

Maximum difference . . . . 2·3
Minimum ,, ... 0·4

Table II.—Handed in by Dr. Rideal.

Date, 1905.	I. 16-Candle. (Size of Chimney, $1\frac{3}{8}$ in.)	II. 5 Cubic Feet. (Size of Chimney, $1\frac{7}{8}$ in.	Difference between I. and II.
May 8	14·4	13·5	0·9
,, 9	14·0	12·6	1·4
,, 10	14·4	12·2	2·2
,, 11	14·5	12·5	2·0
,, 12	14·4	12·4	2·0
,, 15	14·4	13·4	1·0
,, 16	14·5	12·8	1·7
,, 17	14·5	12·8	1·7
,, 18	14·1	12·3	1·8
,, 19	14·05	12·4	1·65
,, 22	14·3	12·7	1·6
Average	14·3	..	..

Maximum difference . . . . 2·2
Minimum ,, ... 0·9

In cross-examination by Sir Ralph Littler, witness said the Committee did not have 14-candle gas before them; they made the recommendation for a 15·5-candle gas.

Re-examined by Mr. Balfour Browne: As the Committee held it was unfair for a 15·5-candle gas, they would have said that it was impossible for a 14-candle gas.

Mr. *Charles Carpenter*, examined by Mr. Rostron, said that clause 6 of the Act of 1900 contained the law on the subject, and was in the Bill as deposited. The original proposal was to have a varying illuminating power from 17 to 14 candles. It was thought that, if it were more economical to have a 14-candle gas, they should have it; and the same with a 15-candle or 16-candle gas. In order to allow those comparisons of illuminating power to be made, the method of testing was introduced into the Bill—the then existing test was applied to the 14-candle gas. In putting this provision in the Bill, they had in mind some observations by Mr. Vernon Harcourt, one of the Gas Referees, on the subject. Mr. Harcourt had pointed out the unsuitability of the "London" argand burner for any gas other than one of 16-candle power. Mr. Harcourt said:

> With the "London" argand, if the consumption were reduced by one-fifth, the yield of light sank to about one-half; and, from the same causes, if the actual quality of the gas were somewhat low, the yield of light, when the consumption exhibited 5 feet an hour, was greatly reduced. Thus any deficiency in the gas was much exaggerated. A more just estimate could be formed by setting the light in the burner equal to 16 candles, and observing the rate of consumption. This should not be lost sight of in any future Bill touching the mode of testing the illuminating power of gas.

Experiments had been made as to the effect of the change proposed by the Bill upon his Company's gas. An argand burner was used, so arranged that the whole of the air supply should pass through an orifice at the bottom. It was found that the addition of a globe made no difference whatever to the illuminating power of the gas. The orifice at the bottom was connected with a very carefully balanced holder containing air, connected with a meter; and the amount of air flowing to the burner under different conditions was measured. They found that when they were burning gas by the method prescribed in the Bill (5 cubic feet per hour), a gas which without the globe had an illuminating power of 14·46 candles was reduced to 13·22 candles. They varied the volume of air required to develop its illuminating

power, and found that, with the method prescribed by the Bill, eight volumes of air were drawn in by the inductive action of the chimney. With eight volumes of air, the 14·46 candles was reduced to 13·22 candles. By reducing the volume of air, the illuminating power was raised to 16 candles. Measuring the amount of air introduced in testing the gas in the present method, they found that about seven volumes of air were required to one of gas; but by testing it in the method prescribed by the Bill they found that eight volumes of air per volume of gas were drawn into the burner.

Mr. ROSTRON: Was the effect a very large difference in the illuminating power of the gas?

Witness: Yes. In the first experiment 13·22-candle power was raised to 16 candles, by reducing the air supplied to the burner.

Does this 3 candles represent the difference between the two methods of testing?—Under some circumstances the difference has gone up to 3 candles. The maximum of the tests which were made at Bankside was 2·98 candles.

Has the general result of these experiments been to confirm the evidence already given to the Committee, that there will be a great difference between the two methods of testing as applied to your gas?—Yes. It proves that if we are to conform to the new methods of testing we should have to resort to expensive and unreliable means of enriching our gas. We could no longer supply gas made from ordinary Newcastle coal.

The following table was handed in by witness:—

Experiments with a Measured Air Supply to a No. 1 Argand Burner.

A. Illuminating Power of the Samples of Gas taken as Tested by the Official Method.	B. Consumption of Gas.	C. Size of Burner Chimney.	D. Illuminating Power of the Gas-Flame.	E. Rate of Air Supply to Maintain the Gas-Flame in Column D.	F. Volumes of Air required per Volume of Gas.	G. Percentage of Air excess over Best Result.
Candles.	Cubic Feet per Hour.	Inches.	Candles.	Cubic Feet per Hour.	Cubic Feet per Hour.	
No. 1—						
14·46	5 54	,,	16·00	..	..	..
,,	5 00	6 × 1⅛	13·22	40·30	8·06	31·27
,,	,,	,,	14·46	39·00	7·80	27·04
,,	,,	,,	16·00	30·70	6·14	..
No. 2—						
14·64	5·53	6 × 1⅛	16·00	..	..	..
,,	5·00	6 × 1⅛	13·06	41·00	8·20	26·15
,,	,,	,,	14·64	34·50	6·90	6·15
,,	,,	,,	16·00	32·50	6·50	..
No. 3—						
14·71	5·50	6 × 1⅛	16·00	..	..	..
,,	5·00	6 × 1⅛	12·78	41·60	8·32	37·07
,,	,,	,,	14·71	33·03	6·61	8·90
,,	,,	,,	16·00	30·36	6·07	..
No. 3A—						
,,	,,	,,	13·21	40·64	8·13	28·44
,,	,,	,,	14·71	34·91	6·98	10·27
,,	,,	,,	16·00	31·64	6·33	..
Averages of four experiments			13·07	40·88	8 17	30·51
			14·63	35·36	7·07	12·94
			16·00*	31·30	6·26	..

* The colour of this gas-flame closely resembles that of the pentane flame, which was not the case with the poorer ones.

In cross-examination by Sir RALPH LITTLER, witness said he did not put all this before the Departmental Committee. There was not one word as to the effect of the argand burner.

Re-examined by Mr. BALFOUR BROWNE: The different volumes of air required made this test an improper one. If one wanted a uniform test, it was not fair to have one that involved very considerable variations in the air supplied to the flame.

Mr. *D. Irving* was then called, and in answer to Mr. ROSTRON, said the Institution of Gas Engineers was strongly of opinion that to apply the method of the Bill to testing all qualities of gas would be objectionable, and prejudicial to the interests of both manufacturers and consumers. The Institution considered that if a uniform method was to be adopted it should be one capable of representing accurately the true value of gases of different illuminating powers. In this country generally gas was supplied varying in illuminating power from 18 down to 12 candles; and this method would not be applied to these gases. Under these circumstances, it was, in his view, a retrograde action on the part of Parliament to put it upon the London gases, which varied from 14 to 16 candle power; and it would be even worse to put it on the nation generally. The quality of the gas was a matter which had to be considered. He would not test all gases by exactly the same method, if one got its illuminating power from coal and the other from carburetted water gas.

Mr. *Charles Hunt*, examined by Mr. ROSTRON, said the method of testing all qualities of gas in the "London" argand burner at a fixed rate of 5 cubic feet per hour was quite unreliable. He had had to discard it many years ago. He found that adopting the 5-feet rate did not give uniform results; it did an injustice to the gases of lower quality. He adopted the method of burning every gas at a fixed height of flame, as prescribed by section 6 of the South Metropolitan Act of 1900. This method was the proper one, in his opinion.

Cross-examined by Sir RALPH LITTLER: In his opinion, the Departmental Committee made a great mistake. He knew that in "Field's Analyses" the whole illuminating power was taken as per the "London" argand burner, and that was the burner used by the Gas Referees.

Mr. *W. R. Herring* agreed with the two preceding witnesses as to the impropriety of forcing an inaccurate test as between the public and makers of gas. It would lead to a considerable amount of ill-feeling between gas companies and corporations all over the country.

Mr. BALFOUR BROWNE said this was all the evidence he proposed to call for the South Metropolitan Gas Company: but he had two witnesses for the Commercial Gas Company. He did not propose to give any evidence for the Gaslight and Coke Company.

Mr. *Otto Hehner* was then called. In reply to Mr. BERNARD WILKINSON, he said he had recently conducted a number of experiments comparing the method of testing 14-candle gas at present in use with that proposed by the Bill, using the Commercial Company's gas in one of their testing-stations, in some cases without giving notice. He had also tested a gas which had stood for some days in a holder. The burner was obviously made to bring out some good quality of the gas. Being intended to give light, it should be used under such conditions that it would emphasize the best qualities of the gas. The present burner used for testing gas had been constructed to educe from a 16-candle gas, not the maximum, but a fair share of its value. If the burner was supplied with an insufficient quantity of gas for its purposes, the result was unfair. He put in the following table:—

Description of Gas.	Illuminating Power.		
	16-Candle Distance.	5 Cubic Feet per Hour.	Difference.
	Per Cent.	Per Cent.	Per Cent.
Service gas with 30 per cent. water gas	15·57	13·84	1·73
,, ,, ,,	14·92	14 26	0·66
,, ,, ,,	15·20	13·20	2·00
Same gas stored for four days	14·12	11 09	3·03
Service gas with 30 per cent. water gas	15·82	14·53	1·29
,, ,, ,,	14·91	13·96	0·95
Same gas stored for three days	14·74	12·21	2·53
Gas with 40 per cent. water gas	15·20	14·14	1 06
,, 45 ,, ,,	14·53	12·70	1·83
,, 35 ,, ,,	15·33	13·80	1·53
,, 40 ,, ,,	16·27	16·27	Nil.
,, 60 ,, ,,	15·05	14·14	0·91
Pure coal gas	15·71	15·49	0·22
,, ,,	16·47	16·47	Nil.
Same gas stored for four days	15 60	13·90	1·70
Pure coal gas	15·40	14·65	0·75

Mr. *H. E. Jones*, in answer to Mr. BERNARD WILKINSON, said he advised the Commercial Gas Company, in view of the great demand for gas for power purposes, that, in their Bill of 1902, they should seek authority to lower the illuminating power of the gas, and in this way follow the precedent of the South Metropolitan Gas Company, who had, in 1900, reduced their illuminating power by two candles, and had simultaneously accepted a reduction of their standard price of gas by 2d. per 1000 cubic feet. For the purpose of making the progress through Parliament simple, they adopted *ipissima verba* from the South Metropolitan Act the price clause and the dividend clause, with variations, *mutatis mutandis* for the different scales of the Company. At that time there was no knowledge as to what that would mean to them beyond the example of the South Metropolitan Company. He urged his Board in the direction of supplying a heat and power gas rather than a bare illuminating gas, taking illumination on the old lines, which were practically abandoned nowadays. The illuminating value of gas was due to its heat and not to its value in an argand burner. They brought in a Bill with no bad faith, and no idea that there was anything in the question of testing. The matter was put to him in the witness-box by the Chairman of the Committee, "Did he wish to get any factitious advantage or chance advantage by altering the method of testing which was then being opposed by the County Council, who had not opposed it in the other case?" And he said no; he desired no such advantage. All his aim was to have the full 2 candles reduction. His view in making the reduction of 2d. was combated by engineers. They said he was giving too much in value, and he believed he was, because the illuminating power in an argand burner was not the value of the gas; the value was its heating power. He had made special contracts with large users of power in Milwall for gas for driving engines, at a discount of 20 per cent., which was considered quite a heroic reduction in those days. Under the pressure of the County Council, he left the illuminating power and said he would be content to take what the London gas would give them. In the Bill of 1902, the clause describing the method of testing was similar to that adopted in 1900 by the South Metropolitan Gas Company; but during the passing of the Bill through the Committee, the promoters struck the clause out. When it came to the test, the Referees very properly pointed out that their hands were tied. By a very old Act they had the burner, and by the General Act they had the 5-feet fixed; and they were not able to prescribe afresh a system of testing which would have given the fair value of the gas. Consequently, the Company's gas was tested at the 5-feet rate. The result was that, instead of being able to reduce their manufacture by 2 candles, they were only safe in reducing it by one. They had to make 15-candle power to ensure getting 14 candles.

A GAS REFEREE ON THE PROPOSED TEST.

Mr. *A. G. Vernon Harcourt* was then called by the Committee; and, in answer to the CHAIRMAN, he said that he had heard several witnesses say that it was not possible to test 14-candle gas in the way proposed by the Departmental Committee. He had listened to these statements with surprise, for the reason that the 14-candle gas had been tested in this way under Provincial Acts passed from 1876 to 1901. Those Acts incorporated the Gas-Works Clauses Act of 1871, which prescribed that the gas should be burnt at the rate of 5 cubic feet an hour. These Acts uniformly named the burner to be employed as Sugg's

"London" argand No. 1; and the value of the gas to be maintained was 14 candles. Then all over the country it had been the custom to test gas in the manner proposed by the Departmental Committee; and the gas had, so long as he had had to do with gas, been called a 14-candle gas. A change was made at the time of the passing of the Bill of the South Metropolitan Company in 1900. The Company proposed, and the Committee sanctioned, the lowering of the power of the gas from 16 to 14 candles. There was also a further lowering of the value of the gas due to the change proposed in their Bill in the manner of testing. The difference between the method proposed by the Departmental Committee and that of the Company he would estimate at only a single candle; but if the evidence given by the South Metropolitan Company was correct, the gain made by the Company was more than this—1½ or 2 candles, perhaps. He understood Mr. Dibdin and Mr. Hehner to say that their testings were made by the official photometer in one of the testing-stations. The mode proposed by the Gas Referees for a 14-candle gas was that the position of either the standard burner or the 10-candle lamp should be so changed that the value obtained when the gas was burnt at the rate of 5 cubic feet would be 14 candles. If it were the case that the testings, of which an account had been given, were made in the official photometer without a change in the position of one or other of the two lights which were compared, then the discrepancy, otherwise almost inexplicable, was explained—viz., that the results obtained by the Gas Referees with their testings showed between the two methods a change of one candle, and the tables which had recently been put before the Committee showed a very much larger change than this. The reason he was doubtful as to the change being made was that a photometer without structural alteration did not permit of the moving of the position of the burner.

The CHAIRMAN asked what was the definition of a 14-candle gas.

Witness said that, until the year 1900, it meant a gas which, burnt with a Sugg's "London" argand burner at the rate of 5 cubic feet an hour, gave a light of 14 candles. By the Act of 1900, the meaning of the term was changed, for it meant such a lower quality of gas as, when giving a light of 16 candles, was burning at a certain proportionate rate to 5 cubic feet an hour. The value thus ascertained was a higher one than that given by the other mode of testing.

In reply to further questions by the COMMITTEE, witness said the amount of air drawn in depended upon the quality of gas which was burnt. If the chimney was sufficiently large, the quantity of air drawn in would be greater when a richer gas was burnt. The total amount of heat would be measured, the temperature within the chimney would be measured, and the rate of the current of air passing up, together with the gas, would be greater. The supply of air was not regulated to suit the gas which was being tested; there was no provision in the burner itself for varying the supply of air. He thought the method of testing proposed by the Bill was much more suitable to the higher quality gases than to the lower ones. He did not think it was correct to say that the burner was originally brought into use for 16-candle gas. Actually, the then Referees made a change in the chimney which they prescribed to be used according as the gas tested was of 16 or of 14 candle power. Having in view the variation in the supply of gas, they sought to correct it by a smaller chimney. His present opinion was that the testing-burner was very little used by the consumer. He thought it was better to leave it to the gas companies to send out for use the best flat-flame burner they could get (he did not suppose the day was near when it would be quite superseded by the incandescent burner), and then to name whatever quality of gas was found to be equivalent, when that burner was used, to the gas as tested by the argand burner. He would leave it to the Companies from time time, as improvements were made in flat-flame burners, to give the best they could get. In that case, the result would be that a lower value would be named as that of the gas; and he understood that the chief ground of objection to the recommendation of the Departmental Committee was that the gas had to be called 13-candle power gas instead of by the more honourable name of 14-candle gas. No doubt the use of a flat-flame burner would have that disadvantage; otherwise he believed there would be great advantages if the change could be made.

The CHAIRMAN: I take it you think the test proposed in the Bill is not the best which could be devised?

Witness: No; I agree with the Gas Companies in that respect. I think the method of the South Metropolitan Company of burning gas, retaining the argand burner, at such a rate as to give a light of 16 candles is preferable to burning at the rate of 5 cubic feet an hour. I consider their objection is just; and I think the proportions are given better by the method of the South Metropolitan Company than by the method of the Bill.

SUMMING UP FOR THE COMPANIES.

Mr. BALFOUR BROWNE then summed up the case on behalf of the Gas Companies, pointing out that the matter was a serious one for them. Lord Rayleigh's Committee did not have the particular point before them. They assumed it was merely a question of nomenclature, and that if they called the 14-candle gas 13 candles it would be equivalent to testing by the 16-candle power method, and that no injustice would be done. But this was not the case; and he believed that if Lord Rayleigh were sitting as a member of the present Committee they would have convinced him that the test which he proposed was not a scientific one.

Sir RALPH LITTLER, in the course of his speech for the promoters, said he was prepared to make an alteration to clause 3 to read "to be used with a chimney of such dimensions as the Gas Referees shall prescribe." This, of course, would be subject to appeal to the Chief Gas Examiner. If the Committee thought it right to make this alteration, he had no objection, because he wished to deprive the Companies of every legitimate grievance, or even every illegitimate grievance, so long as it did not affect the principle of the Bill. They did not want people in London to be misled by thinking they had 14-candle gas when such was not a correct description of it. If clause 4 were not passed, he asked the Committee to allow the Bill to be withdrawn. It was not fair to the County Council that they should have gone to the expense of promoting a Bill merely to give the Companies the part they liked, and not the part the Council liked.

THE TESTING CLAUSE REFUSED.

The room was cleared; and on the re-admission of parties,

The CHAIRMAN said: The Committee consider that the test as prescribed in clause 3 of the Bill is not a satisfactory one. This clause must be withdrawn in favour of the present law.

Sir RALPH LITTLER (after consulting with his clients): Then, my Lord, we need not trouble your Lordships further; we respectfully withdraw the Bill altogether.

Mr. BALFOUR BROWNE said the question they had been discussing was how gas was to be tested. There were various other things which were put in by the Committee in the other House—very important matters. First, for instance, there was the three days' test. The Companies desired to keep that. With regard to sulphur, upon the recommendation of the Departmental Committee, certain provisions were put in the Bill. The Companies had a Bill in the other House; and in virtue of getting the clauses which they desired in the present Bill they withdraw their own. He asked the Committee to give the Gas Companies the conduct of the Bill, to carry it through in the way the Committee had modified it; otherwise they would have been jockeyed out of their own Bill, and would not get what their Lordships had given them—viz., a proper method of testing, which they had proved up to the hilt to be so, and which their Lordships were convinced was the right thing to have in the Bill. Under these circumstances, the Bill was not the property of the promoters. It was the property of Parliament; and he asked their Lordships to reserve the power for his clients to carry on the Bill, modified in clauses 3 and 4 in the way they had directed.

Sir RALPH LITTLER said that was utterly impossible.

Mr. BALFOUR BROWNE said it was not. It had been done repeatedly. The Bill belonged to Parliament, and not to the promoters. The Companies would take the burden of the Bill upon themselves, and carry it through.

The Committee then consulted the authorities of the House *in camera*. On re-admission,

The CHAIRMAN asked whether the promoters had any clause to substitute for that which the Committee had struck out of the Bill or whether they wished to withdraw it altogether.

Sir RALPH LITTLER said it was a matter of the greatest possible public interest, and his clients wanted to arrive at some just conclusion on the matter without destroying the Bill.

Counsel then agreed to ask the Committee to adjourn the matter; and the CHAIRMAN consenting, the Committee adjourned till Tuesday, July 4.

HAYLING ISLAND GAS SUPPLY.

The Local Authorities and the Gas Company's Order.

It may be remembered that among the applications for Provisional Orders in the present session was one by the Hayling Island Gas Company, Limited, for power to maintain and continue gas-works, and to manufacture and supply gas in the parishes of South Hayling and North Hayling in the county of Southampton. The consent of the Havant Rural District Council, as the road authority for the parishes in question, was produced; but the promoters failed to obtain the consents of the Local Authorities, and asked the Board of Trade to exercise the powers conferred upon them by the Gas and Water Works Facilities Act, 1870, and dispense with these consents. The Board accordingly held an inquiry at their office, and invited the attendance of the authorities concerned. The inquiry was attended by a representative of the Havant Rural District Council; but the South Hayling Parish Council and the North Hayling parish meeting were not represented, and made no communication to the Board. The Councils named had previously lodged objections to details of the Draft Order, and they were considered. After hearing the explanations of the promoters, the representative of the Rural District Council withdrew their objections. In these circumstances, it did not appear to the Board that there was any ground for refusing to grant the promoters the statutory powers asked for; and therefore they decided to dispense with the consents of the authorities and grant the Order, with such modifications and amendments as were necessary. They have reported the matter to Parliament, as required by the Act.

LEGAL INTELLIGENCE.

The Ilford Gas Company and Damage by Floods.

In the Court of Appeal last Friday, the Master of the Rolls and Lord Justice Cozens-Hardy had before them an appeal by the Ocean Accident and Guarantee Corporation, Limited, from the order of Mr. Justice Darling, dated Feb. 20, striking their name out as plaintiffs, and leaving two other co-plaintiffs to carry on the case against the Ilford Gas Company. The action was brought by two sets of plaintiffs, the first and second mortgagees of certain premises and land which it was alleged the defendants had damaged by wrongfully stopping up a stream known as the Aldersbrook. Defendants said what they did was under statutory powers. At the conclusion of the trial, which occupied several days, the Jury disagreed; and defendants then raised the point of law that the Corporation were not entitled to sue because at the time of the flood they were not in actual possession of the property. This contention was upheld by the learned Judge; and he ordered that their name should be struck out as plaintiffs, with costs. (See "JOURNAL," Vol. LXXXIX., pp. 366, 585). Mr. Shearman, K.C., and Mr. D. C. Leck appeared for the appellants; Mr. Duke, K.C., and Mr. Mayer represented the respondents. Their Lordships allowed the appeal, and ordered the plaintiffs' name to be restored to the record.

MISCELLANEOUS NEWS.

CONTINENTAL UNION GAS COMPANY, LIMITED.

Modifying the Regulations.

An Extraordinary General Meeting of the Company was held last Tuesday, at the London Offices—Mr. ARTHUR LUCAS in the chair—for the purpose of considering, and if thought fit passing, the following resolution :—

> That the regulations contained in the printed document submitted to the meeting, and for the purpose of identification subscribed by the Chairman thereof, be and the same are hereby approved, and that such regulations be and they are hereby adopted as the regulations of the Company to the exclusion of all the existing regulations thereof.

The SECRETARY (Mr. W. Martin) having read the notice convening the meeting,

The CHAIRMAN said, as stated in the circular issued with the notice convening the meeting, the Articles of Association of the Company, which were adopted when the Company was incorporated in 1864, had become in several respects out of date. This was due not only to changes in the Companies Acts, but also to decisions of the Courts and variations in practice. Dealing first with the changes in the Companies Acts, the principal alterations were due to the Act of 1900. For instance, under that Act, regulations were made as to the calling of extraordinary meetings on the requisition of members. These regulations were to some extent at variance with those contained in the original Articles. Similarly, the Act of 1900 contained statutory provisions as to the appointment of Auditors. It was a matter of importance that the Articles of the Company should be strictly in accordance with the statutes, so that no confusion might arise. Dealing next with the question of practice, in recent years practically standard Articles of Association had come into vogue. It was now the rule of the Stock Exchange that in all cases where a quotation was desired, the Articles of the Company must be submitted to the Committee of the Stock Exchange for approval, so that they might be satisfied that there was nothing in the Articles inconsistent with the proper granting of a quotation; and this no doubt had tended to the adoption of the standard forms. These standard forms differed a good deal from the original Articles of the Company; but he thought he might fairly say that they were, if anything, more in favour of the members of the Company. He should explain that, in the present case, a print of the new Articles had been submitted to the Committee of the Stock Exchange, and had been formally approved; so it might be assumed that everything was in order, and that the Articles contained all the safeguards for the protection of the stockholders which the Stock Exchange considered necessary. In accordance with the promise he (the Chairman) made on behalf of the Board to the stockholders at the ordinary meeting in December last, and in order to make the promise obligatory on this and future Boards, they had inserted a clause in the new Articles requiring the circulation of the annual report and accounts among the stockholders. Dealing with the question of alterations in the law due to legal decisions, the principal point was in connection with the purchase of shares in the the Company during the years 1883-1888. At that time, it was not considered that such a purchase was illegal—in fact, it was only settled by a decision of the House of Lords in 1887. The circumstances under which these shares were purchased were that the Company realized a considerable sum of money in 1882 by the sale, at a profit, of a part of its holding in the Compagnie l'Union des Gaz. The Directors of that day thought that the best way of dealing with the funds was to purchase some of the ordinary stock of the Company. The cost of the £60,000 stock was just under £95,000; but the Directors thought it right to write down the value of the stock to par by applying to this purpose all surplus dividends, which would otherwise have been payable on the stock, in excess of 5 per cent. This process was completed in 1903; and since then the £60,000 of stock had been disregarded for the purpose of dividend—all the profits which it had been decided to divide being allocated to the other stockholders. The total dividends which would have been paid on this £60,000 stock, if it had been outstanding, were estimated at £134,000, and deducting from this amount, the £35,000 employed to write down the stock to par, it would be seen that there was a balance of some £99,000, of which the proprietors had had the benefit. It was only within the present year that the attention of the Board was called to the fact that the purchase of the stock was *ultra vires*, and that it was their duty to put the matter right. Three courses were open to the Directors. The first was to take steps to reduce the capital of the Company by cancelling the £60,000 of stock. This would have involved an application to the Court, and the Company would have had to describe itself as "limited and reduced" for several months. The Directors felt that this would be misunderstood abroad, and might prejudice the Company. A second course would have been to reconstruct the Company by winding up and selling the undertaking to a new Company for £940,000—*i.e.*, a reduction of £60,000 on the present capital. This, however, would have been very expensive, and might have given rise to difficulties in connection with the transfer of the Company's foreign concessions. The third alternative was to dispose of the stock by sale; and this the Directors decided to adopt. The present articles, however, contained a provision prohibiting the Company from selling any of its own shares or stock which it might have acquired. If the new Articles were adopted, the Directors would be free to dispose of the stock; and as stated in the circular, they proposed to offer it in the first instance to the stockholders. Stockholders had had an opportunity of inspecting the draft of the new Articles; and he therefore did not think it necessary to go further into detail. He moved the resolution as given above.

Mr. FREDERICK TENDRON seconded the resolution.

Mr. G. A. CAVE ORME said he wished to propose an amendment with regard to Article 77, which dealt with the Directors' remuneration. He moved that all that section from the words "and in case" be omitted, which would leave the Article—"The Board shall set apart and receive for their remuneration in each and every year, out of the income of the Company, the sum of £2500; and such annual sum shall be divided amongst the Directors in such manner as the Board shall from time to time determine."

Mr. W. E. BARTRAM seconded the motion.

Mr. WALTER HUNTER asked whether this was the same clause as was in the former Articles of Association.

The CHAIRMAN said that gave him the opportunity of saying that the Board had thought it better not to touch the clause at all. It had been a difficult matter to deal with.

Mr. E. CLARKE said it was very inconvenient and distasteful to speak of this matter. But the affairs of the Company had been brought to such an unsatisfactory condition that he and many of his brother shareholders thought these were not times in which they could be more than just to those who represented them. They could not be liberal. It would be far wiser to leave the remuneration at £2500, and such other sum as the shareholders should determine the Board were entitled to. He thought it would be a graceful concession on the part of the Board if they would allow the amendment to go through.

The CHAIRMAN said the Board were quite ready to accept it. They would have done so before because they all disliked the clause, but they thought it better not to touch what their predecessors had framed, and the proprietors had accepted in past years. They would at once delete it from the words mentioned. It was only a matter of form, and did not require an amendment.

Mr. CAVE ORME said that was quite sufficient.

The CHAIRMAN, in reply to further questions, said he could not say what would be the price at which they would issue the £60,000; it would be issued later on to both the preference and ordinary proprietors who were entitled to an allotment; and it would be used to the best advantage of the Company. They would no doubt be glad to report to the proprietors what they were doing with the money at the December meeting; but they had not got it yet.

The motion was unanimously carried.

The Case of Graham, Morton, and Co. v. Compagnie L'Union des Gaz.

STATEMENT BY THE CHAIRMAN.

The CHAIRMAN said the meeting that had been convened for a special matter was at an end; but he wished to avail himself, as Chairman, of this opportunity of speaking about a case which had been rather a prominent one of late. It was that of *Graham, Morton, and Co. v. The Compagnie L'Union des Gaz*, in which their own Company were so largely interested. He did not want to wait until the December meeting before referring to it, seeing that the Board had the advantage of the presence of the proprietors that day; and it would be much better to at once make a clear statement on a point which had, perhaps, exercised some of their minds. As some of the stockholders were aware, in January, 1902—in order to reduce the cost of labour, and at the same time meet the increasing demand for gas in the City of Milan—they concluded contracts with Messrs. Graham, Morton, and Co. for the erection of four benches of inclined retorts, which had to be, and were, built and completed in eleven months. He must ask the proprietors to bear in mind the fact that the necessity for the erection of works of this magnitude, in this remarkably short space of time, was due to the fact that it was of paramount importance to reduce the number of men employed in the works on account of the labour troubles that were then acute. The working of these benches began and went on till about February, 1904; and during the whole of that time, the results were, in the Board's opinion, disappointing. Pressed as they were to fulfil the contract which at Milan was an exceptionally onerous one, they decided, after consultation with their Engineers, to open up one of the benches, in order to discover the cause of the failure. The condition of things revealed, necessitated, in the opinion of other experts called in specially to advise the Board, the demolition of all the benches, and justified them in advising that the Company had a good case against the contractors, against whom they were advised to claim damages. The case was tried by Mr. Justice Grantham, and was decided against the Company. He did not propose to express any opinion that day on the decision; and, indeed, it was not fit that he should do so. The Directors accepted it; but on one point he wished to take exception to the learned Judge's strictures on the Board of the Company. As he had said, the work had to be done in a limited time. They employed Messrs. Graham, Morton, and Co. as specialists, expert designers, and contractors. They promised the Company the same installation as in Edinburgh, which the Directors were informed was an exceptionally successful one; and they stipulated that they should be in no way interfered with. Under these circumstances, the Board deliberately decided to leave the erection of the benches to the Contractors, who took the whole responsibility for them, and gave the fullest guarantees both as to workmanship and design. Mr. Justice Grantham appeared to consider this was the ordinary case of building a house, when an architect was employed, who designed the building, and who employed a clerk of the works to supervise the contractor. In their case it was for Messrs. Graham, Morton, and Co. to employ the clerk of the works to supervise their own workmen, and not for the Company. Mr. Justice Grantham stated that he did not believe his (the Chairman's) evidence on this point; and he (Mr. Lucas) wished to take this opportunity of assuring the proprietors that he stated the facts, and that the Board did unreservedly, for the reasons he had given, place themselves in the hands of Messrs. Graham, Morton and Co. The case was an exceptional one; and if the contractors merited the high praise contained in the Judge's judgment, the Board considered they were justified in so doing.

THE ATTITUDE OF STOCKHOLDERS.

Mr. E. CLARKE asked whether the proprietors were justified in offering any opinion upon the matter before the meeting.

The CHAIRMAN: There is nothing before the meeting. It is merely a statement, on behalf of the Board, to justify them in the course they have taken.

Mr. CLARKE said he had been approached by several shareholders who were immensely dissatisfied with the present condition of things; and he was afraid the Directors had not yet done with serious opposition on the part of the shareholders. There were large numbers—he did not speak of himself—who had been shareholders for a great number of years; and they feared that the present was "the parting of the ways." They had been impressed with what had been reported—presuming the reports in the "JOURNAL OF GAS LIGHTING" and other papers were true and just reports—of what had transpired, and felt anxious as to the part they should take in supporting the Board under present circumstances. It was for the Board to consider whether it was desirable for this meeting to discuss or place before them their views, or whether they would wish a meeting which might be called—not in any spirit of antagonism—at which the shareholders' views might be brought before the Directors, at a later time. Sometimes it was wise to hear the views of others, though they might not be able to absolutely adopt them. If the Directors were prepared to hear the views of those in the room, he felt it would be of advantage to the Company; and if the Chairman would allow him to speak later, he should be glad.

The CHAIRMAN assented.

MR TREWBY ON MISMANAGEMENT AND THE QUESTION OF A TECHNICAL ADVISER.

Mr. G. C. TREWBY said he was one of the experts called in by the Company; and he had every sympathy with the Board with reference to the way in which the Judge dealt with the case. He would say no more than this, that he thought Mr. Justice Grantham had made up his mind—as far as one could gather—before he heard the evidence in the Company's case. He (Mr. Trewby) was perfectly ready to believe what the Chairman had said as to the Board having put themselves in the hands of Messrs, Graham, Morton, and Co., and that they trusted them implicitly. He was speaking now as an expert; and he believed that the Company had a first-rate case from the technical point of view. Those settings could never have worked, and——

The CHAIRMAN: It would be a grave mistake to retry the case now. This is not a Court of Justice.

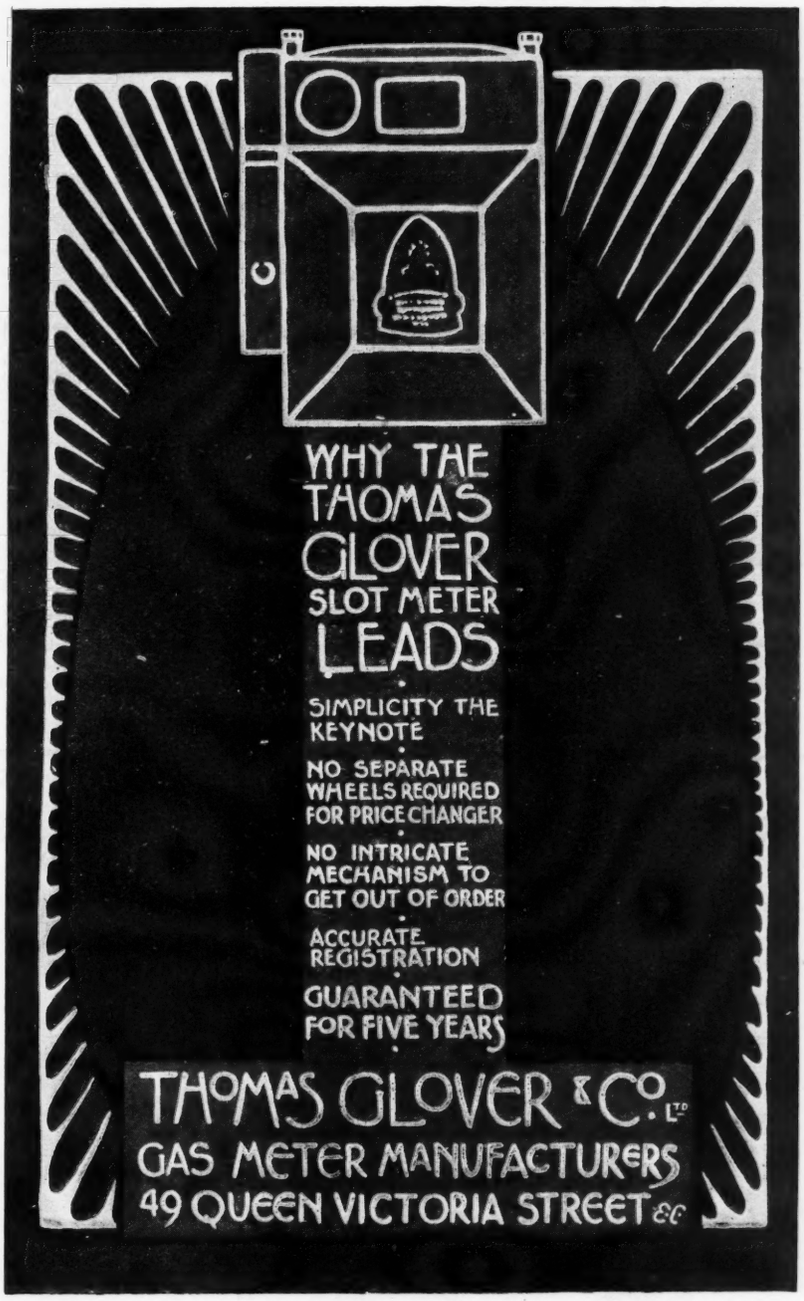
Mr. TREWBY said he would pass from that point. He had been a shareholder in the Company for the past eighteen years; but this was the first meeting he had attended. He found his shares had gone down in value more than half; and he was receiving half the dividend he had originally. From what came out at the trial, he had an uneasy consciousness that things had not been going on as they ought to have done; and this was manifest to anyone who had taken the trouble to read the proceedings. He had had upwards of fifty years' experience in gas affairs; and he felt bound to say that what came out at that trial showed an amount of mismanagement on the part of the Company that was unparalleled in his experience. What had been done showed this, that the Board had apparently no confidence in their engineering staff. The Board put this contract into the hands of a contractor; and they told their Engineers to stand on one side altogether—the consequence being that they had this unsatisfactory result, which would cost the Company no end of money. He had been in communication with several of the shareholders; and they were all of his way of thinking, that what the Board wanted more than anything else was a technical Director sitting with them to advise them. It was not competent for the Directors to determine upon matters of engineering unless they were fortified with proper technical advice. It seemed to him that this was what had been lacking for years. He daresay some of the shareholders would say: "Well, if you are dissatisfied, why don't you sell your stock, and get out of the concern." His answer to this was, that he kept on to his holding in the hope that better counsel would prevail at the Board in the future; and then he should be justified in looking forward to a gradual return of prosperity. He was only a comparatively small shareholder. But he was jealous for the reputation of English management; and he should not like it to go forth to their friends on the Continent that such a state of things as that exhibited during the trial of this action was the way in which an English Company should be managed. Now what he proposed as a remedy was (and he was certain it would be effectual) that the Board should be strengthened by the infusion of new blood of a technical character—that a gas engineer should be elected as a Director who was in every respect up-to-date as far as modern work and appliances were concerned, a good all-round man, and one, if possible, who practised his profession on the Continent, and was thoroughly conversant with Continental matters. This he merely put forward as a suggestion; and he thought, if they got the right sort of man, that they would have an improved state of things. He gathered from the technical journals that the Board were contemplating spending a large amount of money on new works in Milan and Genoa; and it was stated that, in Milan the new works were to be equal to making 14 million cubic feet a day, and in Genoa 10 millions. In both cases, it was stated, inclined retorts were to be put up. Now was the very time they wanted a technical adviser on the Board, so that they might not throw their money away as they had done in the past. As perhaps many of those present knew, he visited Milan to inspect these inclined retort settings. He had no knowledge of what was necessary in gas-works on the Continent; but he was told by a man who had had considerable experience, that inclined retorts in Italy were a mistake. The temperature of Italy was, of course, much greater than in England; and in working inclined retorts in England, they found on the charging-stage that it was very hot indeed. It was the hottest part of the work. But in Italy it was intensely hot—it was unbearable; and therefore they could not expect the men to work inclined retorts with the same satisfactory results in Italy as in England. And they should bear in mind this fact, that inclined retorts had to be fed with coal of a certain character. There was not one-half of the coal in use in this country that would work properly with inclined retorts. These were the few remarks he had to throw out, to show the Board how necessary it was for them to be thoroughly satisfied by technical advice that they were on the right course.

THE BOARD AND TECHNICAL DIRECTORS—DIFFICULTIES OF THE PAST.

Mr. FREDERICK TENDRON (a member of the Board) said he should like to observe that the remarks that had been made came home to the Board; and they were fully aware of all the Company's difficulties. They had been considered by the Board; and he would leave the Chairman to reply on the points, if he considered proper. But with regard to strengthening the Board by the appointment of a technical man who would thoroughly understand these things and advise the Board, he (Mr. Tendron) had found in his experience that it did not do at times to have technical men on a Board. They interfered far too much with the staff and with other things. They had their own ideas; and unless their ideas were adopted, there was a division on the Board—a thing that was most unadvisable. It had been considered, and would no doubt be considered still, and the Directors would not hesitate—he might say for himself, and the other Directors would object if they did not agree—if they saw it was in the interests of the Company, they would appoint such a man as consulting engineer. These were very serious matters; and they engaged their attention, and would continue to engage their attention. With regard to the observations of his friend Mr. Clarke, he wished to goodness he had spoken to him (Mr. Tendron) on this subject. No shareholder could realize what the Board had gone through since 1901. Before that, the Board made certain arrangements with Milan which were to the advantage of the shareholders, and which prolonged the concession to the suburbs and to the town itself from 1911 to 1925; and they did not get changes like this effected without conceding much on their own side. The Company had to bring down the price in Milan at once; and the reduction was one which meant an enormous diminution in profits. It was like the extension of a lease. Instead of having as much profit for a certain number of years, they would have the profits extended—not to the same extent, but for a much longer period. That was one point. Then the taxes were put up; and the Board had those taxes to contend with. They also had a change in the Municipality which was most prejudicial to the Company. They all knew what a Municipality could do, and how they could harass a Company. And so the Company were harassed, and on one of the most important points—that was, the quality of the gas which should be supplied. He did not think he would be wrong if he said that, if they had enforced literally the *titre* they had to supply at Milan, it might have required 17½-candle gas to give the light that was really needed of 13 or 14 candles. It was such an abnormal *titre* that they could not make it work; and the Company had to make a sacrifice to get it changed. They had now the *titre de Paris* instead; and they did not get the authorities to change to this without a great concession. Then there was also the calorific power of the gas; and, moreover, they had to give the same quality throughout the whole twenty-four hours. These were difficulties under which they had laboured; and then they were not supported as they should have been by the municipal, military, and other authorities during the times of trouble with the men. Mr. Justice Grantham had himself mentioned that at their Milan works six men were required to do the work of two. Therefore, now that they were getting a little through these troubles, he appealed to Mr. Clarke, as a shareholder, not to do anything over here in weakening the authority of the Board in any way. He was perfectly welcome to the fullest information. The shareholders would never have again the dividends they had had; they could not expect them. Whenever there were re-arrangements and concessions, the Company must make sacrifices; but what they wanted to see was a firm and reliable dividend in the Union des Gaz. There was no mismanagement in Paris; and there was no mismanagement on the part of the Directors here. They had difficulties to contend with; and those they had to a great extent got over. No men could do more, give more time, or more thoroughly understand the business than they. True, he (Mr. Tendron) did not understand all about inclined retorts. But how could they have a stronger Board than the present one? Mr. Garey had been years and years in the gas world. Mr. Hesketh Jones had had the management of gas-works, and gave to the Company work without end in looking after these things. Then they had Mr. Gardiner who had had a large experience of the Imperial Continental Gas Association. Of that Association, too, the Chairman (Mr. Arthur Lucas) was the Deputy-Chairman, Mr. Birch-enough was also a Director of the Association; and he had won their admiration since he had been on the Board, having great ability in all matters connected with the Company. He hoped Mr. Clarke would not press his measures any further; but if he wanted explanations, he (Mr. Tendron) would go into everything with him.

GUIDANCE FROM THE MISTAKES OF THE PAST.

Mr. CLARKE said he was not speaking in antagonism; but he felt his difficulty was increased, seeing that many of the gentlemen on the Directors' side of the table were personally known to him. They must, however, learn—whether they were a Board or individuals—from the mistakes of the past some little guidance as to the future. He would speak to the Chairman's own words, and ask when these new works were completed what steps the Board took before they took them over? The Chairman had spoken of their having been rushed into the prosecution of these works in a way not at all in the ordinary course of business; and the Deputy-Chairman had told them of the circumstances under which it was obligatory to carry them out. This being so, what steps did the Board take before they took the works over to safeguard themselves, to see that the works were what they purported to be, and to see that the conditions of the contract had been carried out. He was sorry that the state of health of the Deputy-Chairman did not permit him to be also present at the trial, and to give evidence on behalf of the Company. At any rate, as shown in that trial, there seemed to have been no formal taking over—no certificate from anybody in a qualified position to tell the Board they were all right; but the contractor seemed to have



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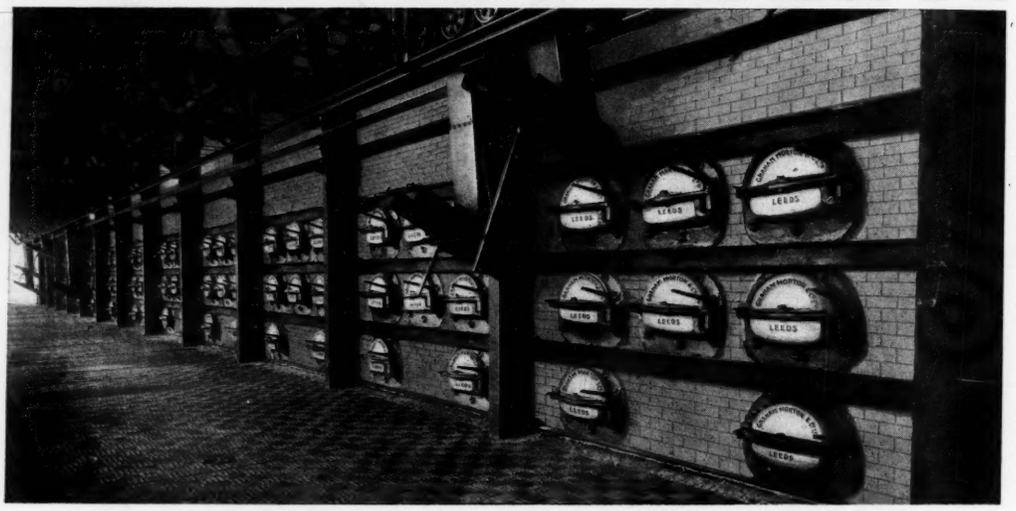

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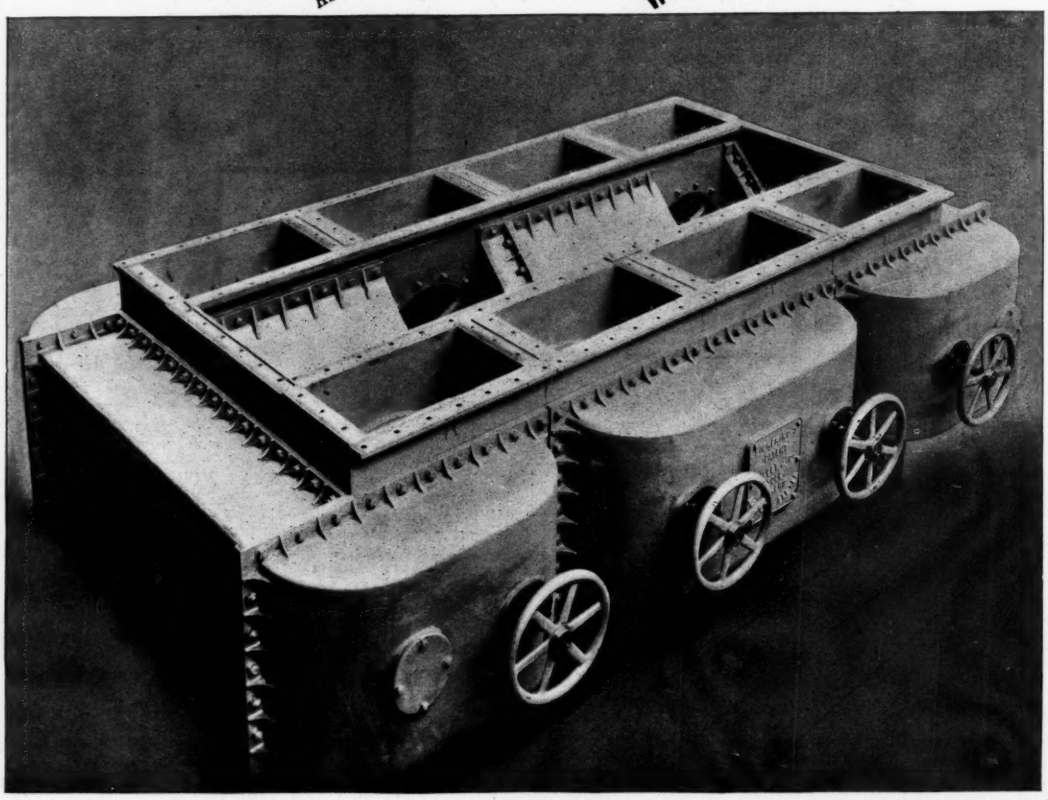

VIEW OF CENTRE-VALVE TO WORK 4 LARGE PURIFIERS, 24-INCH CONNECTIONS. N.B.—THIS IS NOT THE LARGEST WE MAKE, BUT LARGE ENOUGH TO BE INTERESTING

had unfettered control. As business men, it was necessary for the Board to have some certificate which would carry weight as to the work done under these exceptional circumstances having been wisely and well done. As he had said, they only wanted to learn from the mistakes of the past some guidance as to the future. He (Mr. Clarke) knew how exceedingly difficult it was to conduct the affairs of a large Company like this abroad; and he quite realized what Mr. Tendron had just said as to the great conflict they had had with the powers—municipalities and others; how anxious these bodies were to score off them, and how desirous they were to have them at a disadvantage in every way. Therefore he gave the Directors every possible credit for that. But the fact still remained, and must be acknowledged to remain, that this was a terrible mistake. Some of the members of the Board had been in their service for a great many years. They had the power to have ten on the Board; and at present they had only six. He did not ask that any of the Board's older colleagues, because they had got old, because they had become grey-headed, should be shoved or pushed on one side. But he would ask the Board whether they did not see their way to associate with the Board one or two gentlemen who had certain knowledge not only of gas making but the carrying out of the intricacies of contracts in foreign countries. He hoped that no word he had said was in any way personally offensive to any one of the Directors.

FROM THE CONTRACTORS' POINT OF VIEW.

Mr. E. SPYER (Messrs. Spyer and Sons) asked to be allowed to say a few words about this matter, because Messrs. Graham, Morton, and Co. were themselves shareholders in the Company; and he was holding their proxy. As shareholders, they would like an opportunity of making a few remarks on the observations that had fallen from both Mr. Clarke and Mr. Trewby. The first thing he should like to say, on behalf of Messrs. Graham, Morton, and Co., was that they wanted to recognize that Mr. Lucas (the Chairman) had been actuated by motives of the highest conscientiousness towards the shareholders. After having sat through seventeen days of the trial, no one could say the views he had taken or what he said in the box were not absolutely conscientiously taken and said on behalf of the shareholders. That the Board might have committed (he did not like to use any other word) an error of judgment with regard to this particular action, many in the room would recognize; but that they were actuated by any but the best motives to their shareholders, nobody in the room would deny. Mr. Trewby said the Company ought to have a technical man on the Board. He thought Mr. Trewby was stopped by the Chairman very properly when he wanted to re-try the case. However, he said that the Board would not have got into this difficulty if they had had a technical man on the Board. Mr. Trewby was a technical man; and he was one of the Company's experts. From such circumstances, one was rather inclined to think the view that had been expressed from that side of the table was quite right—that what the Company wanted were business men on the Board, and not technical men. He did not want to say anything more about what Mr. Trewby said than that. There was, however, one other observation he desired to make. Mr. Trewby had taken the Board to task, and Mr. Clarke to some extent, in quite a friendly manner, when he said that it was not business-like of the Board to leave the whole of this matter of the new works in the hands of the contractors. Mr. Lucas gave an explanation of this point when he was examined which must have appealed to everybody who heard it. He said that Messrs. Graham, Morton, and Co., were recognized as the premier firm in regard to this kind of work. The work had to be done rapidly; and Mr. Graham made it a condition that, if he was to carry out the work in the time to which he was limited by the contract, he must have a fairly free hand. Now, it was true the contract provided differently; but he was not here to say, on behalf of Messrs. Graham, Morton, and Co., that he did not stipulate for a free hand. Therefore, to that extent, the Chairman was perfectly justified in what he stated in the box. But what must not be lost sight of was that the judgment had been accepted by the Board. Messrs. Graham, Morton, and Co.'s work had, by the findings of the Judge, been accepted as everything it ought to have been; and therefore the confidence that the Chairman said the Board had reposed in the Contractors had been fully justified. He gathered from the observation of the Chairman that nobody wished to question that. There was one other matter that ought to be referred to, and that was the suggestion that there had been some sort of mismanagement on the Directors' side of the table. They all knew that, when a Board of business men had to deal with a question of this sort, the first thing they did was, and naturally, to go to their technical officers, and say: "Now this is the position. We are not satisfied with what we have got; what are we to do?"

Mr. TREWBY: I rise to order. Is not this re-trying the case?

Mr. SPYER: I am not going to make any observations as to——

Mr. TREWBY: He is the Solicitor to the Contractors; and he is re-trying——

Mr. TENDRON: We are all more or less out of order.

The CHAIRMAN: You may go on, Mr. Spyer.

Mr. SPYER (continuing) said he was saying that the Board went to their experts, and took their opinion. The only thing he had to say about it was this: If the Board had suffered from any mismanagement, or if there had been any mismanagement, it was obviously clear they did the right thing for a Board to do. They relied on experts; and, if unfortunately the experts were wrong, the Board were perfectly justified in saying: "Gentlemen, we did the best we could in your interests, and to protect your interests."

Mr. TREWBY: I hope I shall be allowed to reply. He is entering into matters which I was forbidden to touch upon.

Mr. SPYER added that the Board had done in that respect what everybody would have done. They relied upon experts. The experts may have been honestly wrong; and the Board were entitled to say that.

THE COMPANY'S ENGINEERING STAFF.

Mr. TREWBY remarked that the last speaker had said the Board relied upon their technical experts. When the Board got these experts was when they found the working unsatisfactory, and they were dismantling the second bench. The Company had started an action against Messrs. Graham, Morton, and Co., for damages before the technical experts were called in; and when the technical experts examined the benches, they reported to the Board that they had inherent defects. And he had not the slightest hesitation in saying, if this case had been tried before a technical engineer, it would have had a different result But what he was going to say was this, that the reason the case failed was not on account of the advice, or bad advice, of the technical experts; but it was on account of the Company's own engineering staff. The Company's own engineering staff absolutely gave the case away when they went into Court. They had themselves to justify what they had done; and, in documentary evidence, they stated that these settings had worked all right from the commencement. The Judge took this view of it. But as a matter of fact "we" knew as well as possible, from the deficit of 16,000 tons of coal that had accrued during the time the settings were at work, that they could not have been working satisfactorily; and, instead of making 10,000 cubic feet or upwards per ton of coal, it worked out, when the deficit was taken into account, at not more than 8000 cubic feet per ton. What could be more convincing than that? And when he (Mr. Trewby) said it was advisable that they should have a technical expert on the Board, what he meant was this, that if an efficient technical expert Director had been on the Board, he would never have allowed the settings to be put up without proper supervision. That supervision was never exercised.

Mr. G. A. CAVE ORME said he was glad to hear Mr. Spyer say that Messrs. Graham, Morton, and Co. had no intention whatever of aspersing the personal integrity of the Chairman. No one in the world would think of doing that. He was well aware that Messrs. Graham, Morton, and Co. would not themselves think of it. Unfortunately that admission did bring into relief one thing—that was, the almost fatal facility that had fallen upon the Board for accepting bad advice. The result had been this, that literally they had seen this Board put their trust in men whom afterwards they had to find were not to be trusted. Some of these men were not now in the service of the Company; and the matter the Board should consider was not so much the appointment of a technical expert to sit with them as a Director on the Board, as to find whether they could get absolutely reliable servants in their most responsible positions. This seemed to be more important than the other. The business of an administration was not to enter into technical details and direction of that sort, but to find men who could do it for them, and such men as they appointed they ought to be able to trust. He had been told in one quarter that one reason the Board had been unable to deal with these things was because of their good-heartedness. They had not liked to seem to be hard upon the people whom they thought deserved well of them, and who had served them faithfully in the past. But the time came when other considerations must be taken into account, and even one or two persons had to be sacrificed. He thought perhaps he had better not say any more; but he must finish by impressing upon the Board the necessity of being sure the people who were in their most responsible positions were such people as they could thoroughly trust.

THE CHAIRMAN AND TECHNICAL ADVISERS.

The CHAIRMAN said he should like to remark that the Board fully appreciated the courtesy of the tone of the remarks that had been made under what they themselves fully appreciated were very trying circumstances. But there was one point of very great importance that he must meet, because it would be a very fatal thing if it were to go abroad. It was suggested by Mr. Clarke that the Board had taken over the installation at Milan without the advice and sanction of any expert of eminence. He ought to say that, when these retorts were first of all finished, Mr. Corbet Woodall went out to Milan; and as far as he could see from the outside, he was perfectly satisfied with them, and, because of the great labour troubles, he then advised the Board to postpone the official tests for a time, and this the Board did. This would show the stockholders that the Board did not sit there and merely take the *ipse dixit* of the Contractors; but they did all they could in their power to safeguard the stockholders' interests, and to see that they did receive value for the large expenditure on these retorts. He thought this very clearly settled that point; but he could not speak too strongly on the fact that the Board would have been almost criminally guilty if they had acted otherwise than they did. Now, with reference to Mr. Trewby. Mr. Trewby had said it would strengthen the decisions of the Board if they had a technical director. But he (the Chairman) wished to point out to the stockholders the great disadvantage of that. An engineer, or as technical director—if they had such a member on the Board—had certain views. All the directors must subscribe to those views; and they were always at a disadvantage in discussing all technical points, for obvious reasons. And they could not get rid of the technical man without a vote of the shareholders. His presence was a cause of constant friction. It was not only a cause of constant friction on the Board, but it was a cause of jealousy between the engineers; and therefore it was very strongly to be avoided. By all means let them have engineering advice. They still had it; and would take good care they had it in the future, as in some cases they had had it in the past. As long as he (the Chairman) had the honour to preside over the Board, he should strenuously oppose—and it was straighter for him to say so at once—the appointment of an engineering director (because he was an engineer) on the Board. Now, with regard to the diminution of the profits of the Company, of course, they were apt to dwell very much on the failure at Milan; and this led him again to refer to Mr. Trewby's remarks. No one knew better than Mr. Trewby when he made those remarks that the cause of the Company's trouble was the disloyalty of the men employed at the works in that city. In England, they had no notion how difficult it was to manage between 700 and 800 Italian workmen. When he (the Chairman) was out there in 1900, it was only by subterfuge that he was enabled to escape a band of hundreds of men who were waiting for him at the station. Luckily he did, by a little diplomacy, get to the station eventually, and get away. They then settled matters; but it took a long time, and it was done under very

difficult circumstances. The fact of the matter was it was not only the disloyalty of the workmen at Milan, but there was also the strong Chauvinist feeling which existed in Italy—to far greater extent than in any other country. As Mr. Tendron put it to the proprietors, this labour question had been a great element in their difficulties in Italy; and these remarks, he might say, applied to all the stations there. There was another cause which he had alluded to over and over again at their yearly meetings. The Board were suffering from the unwise policy of the past of dividing profits up to the hilt. What had been the result? The consumption of gas at Genoa, at Milan, at Alessandria, and at Modena had increased by leaps and bounds—in an extraordinary way in fact. But they had not had money in hand in order to increase their works. If they had had large reserve funds, which he was sorry to say their predecessors never initiated, they would have been able to draw upon them. The Board, however, had borrowed money on the cheapest plan. They had issued bonds, as he had explained over and over again. Their business had taken their whole capital. It was not Milan only this applied to; it was not bad supervison at Milan; it was not the disloyalty of the chiefs there; it was not bad advice at Milan—it was that the business had been too big for the small capital; and this was the cause of the trouble. That was the cause why the dividends had been diminished, and the Directors had been in the most disagreeable position of fighting against circumstances. Circumstances had been too strong for them. He could assure the proprietors that the Board had done their very best. They had obtained the very best technical advice outside that they could have; and they would continue to do so in all technical matters. Having received this advice, they would act to the best of their ability; and they hoped and trusted that the proprietors would go away from the meeting feeling that all the Directors' best energies would be devoted to their interests honestly and truly.

A VOTE OF THANKS—TESTIMONY AS TO THE VALUE OF A TECHNICAL DIRECTOR.

Mr. A. F. PHILLIPS said he did not think they ought to part without a vote of thanks being passed to Mr. Lucas. As to the criticism of the policy of the Company, he (Mr. Phillips) knew something of the great difficulties, from personal experience in Italy, in the management of men and in dealing with the municipalities there; and the Directors had his deepest sympathy in all their troubles. He had much pleasure in proposing the vote of thanks.

Mr. WALTER HUNTER seconded the vote, and hoped it would be applied to the Directors generally. He said he should go away from the meeting quite satisfied in feeling that the Directors intended to do everything possible in order to resuscitate the Company from the position in which it had fallen. He did not wish to enter at all into the question of the technical director; but he must say that he had seen a great deal of good come from the presence of a technical director on the Board of two companies with which he had been connected. He only threw this out as his own personal experience. But he was quite certain the Directors would take the whole thing into their consideration and give a right and wise decision in the matter. Another suggestion he should like to make was this: It did seem to him that, in a country like Italy, where they had the workmen against them, where they had the municipalities against them, and where generally they had the Parliament against them, they ought, if possible, to take some means of bringing the interests of the workmen into the same channel as the interests of the Company. He had seen such great and good work here—in connection with the South Metropolitan and the Commercial Gas Companies—by bringing in the men as partners in the concern, that he was satisfied (although he quite realized that their difficulties with the Italian workmen were far greater than those experienced in this country) it was a matter that should be taken into the Directors' earliest consideration, with the view of bringing about some scheme which would make the workmen the Company's friends, instead of their enemies.

The motion was unanimously carried.

The CHAIRMAN: I am much obliged to you, gentlemen.

A DEFICIT AT BRADFORD.

Cheaper Gas and a Falling-Off in Residuals.

At a Meeting of the Bradford Corporation Gas Committee on Monday of last week, the Chairman (Alderman Hind) presented his report on the working of the undertaking during the year to March 31, which showed a net loss of £1820, as compared with a net profit for the previous year of £9916. As a set-off against this, however, the consumers benefited to the extent of £13,000 by the reduction of 2d. per 1000 cubic feet which came into operation on July 1, and this affected five-sixths of the sales of gas for the past financial year. The gross or trading profit amounted to £60,403, or £11,524 less than for the preceding twelve months. Out of this, interest, stamps, and registration cost £33,603, or £1491 less; but the sinking fund contributions were £25,470, or £1201 more, owing to the charge for the Heaton portion of the Shipley undertaking. The income-tax for the year was £3350, or an increase of £567. Owing chiefly to the continued bad state of trade in the district, and to the bright, warm summer, the sales of gas were disappointing; while the fall in the values of coke and tar seriously influenced the results. Although the coal last year was bought at cheaper rates, the new contracts did not come into operation until October, and therefore the reduction only benefited the Committee during the winter months on two-thirds of the gas consumed in the year. In some portions of the district, the sales of gas during the twelve months to December fell off, while in others there was an increase; the total result over the whole area being an increased consumption of 2·53 per cent. As the consumers' accounts are only made out half yearly, it has been impossible to separate the districts for the first three months of 1905; but the consumption over the whole area for this period (estimated from the output) fell off, so that the total sales for the year to March 31 only show 0·64 per cent. increase.

During the year, 194,390 tons of coal and cannel were carbonized, and 1,908,829,000 cubic feet of gas were sold. The cost of coal and cannel was £100,140, or £7582 (equal to 9·35d. per ton) less than in the previous year. This, however, was not all saving, because a much greater proportion of inferior local coal was used than in previous years. Stokers' wages amounted to £27,175; being an increase of £349. Purification (after deducting receipts for spent oxide) cost £1852, or £916 more. Repairs of works and plant figured at £28,937, or £2233 more—all of which increase was spent on the outside works. Repairs and maintenance of meters, mains, and services cost £13,049, or £282 less. Bad debts came to £1219, or £247 more—which was another effect of the general trade depression. Rates and taxes amounted to £13,020, or £280 more. The stove department cost £100, as against a profit in the previous year of £385. This difference was chiefly due to the cost of fixing stoves and to the institution of the system of incandescent maintenance; but it is anticipated that the expenditure will be more than justified by future results. The revenue from the sale of gas (including that used for street lighting) was £187,970, or a decrease of £3922; while meter-rents were £2275, or £41 more. Coming to residuals, coke yielded £26,393, or £7814 less than in the previous year; and tar only produced £16,306, or £3796 less. The return for ammoniacal liquor and chemical products (including cyanogen) was £21,079, or an increase of £1439.

The unappropriated profits on March 31, 1904, were £8735, out of which £7500 was paid to the Cartwright Memorial Hall Building Fund. This, with the loss realized on the past year's working, leaves a debit balance of £585. To set against this they have, however, a sum of about £9000 interest which has accrued on sinking fund, and which might have been used to reduce the annual payments to the fund or to reduce the bank interest charges. Since the end of the financial year, also, the Council have decided to repay the Committee £5000 from the exhibition profits. In addition, the Committee have £25,000 in their restoration fund and £1701 to the credit of the debenture stock premium account.

The net capital expenditure to March 31 was £1,136,872; and the excess of assets on the same date was £305,149 (if the £5000 repaid from the exhibition profits is included). The heavy expenditure on the works and mains of the added gas undertakings is, it is stated, already being justified by the reduction in the unaccounted-for gas. During the past year, this item has been reduced from 6·09 to 4·83 per cent. The Committee and the Engineer (Mr. Charles Wood) are also to be congratulated on the fact that the net cost of gas into the holders was less than ever before; being only 12·019d. per 1000 cubic feet sold.

For some years past, the Committee have always written down the values of their stocks of coal, coke, tar, &c., when prices have fallen; but they have not made any alteration when rates have advanced. The actual result of this has been to depreciate the value of the stocks on the present occasion by £2802, or nearly £1000 more than the Committee's actual loss. In addition to this, the cost of the street lighting for the year was £29,692, towards which the Committee have received from the Finance Committee £26,000—leaving £3692 to be borne by the Gas Department. Alderman Hind concluded his report by remarking that, considering the serious drop in the prices obtainable for coke and tar, and the reduced consumption of gas in the first quarter of 1905, there was reason to be thankful that the result of the twelve months' working was not much worse.

THE YEAR'S WORKING AT BURY.

At their Monthly Meeting last Thursday, the Bury Town Council considered the reports of the Engineer (Mr. H. Simmonds) and the Auditors (Messrs. C. M. Merchant and Son) on the operations of the gas-works during the twelve months to March 31.

Mr. Simmonds stated that the make of gas for the year (including 130,000 cubic feet from benzol) was 396,301,000 cubic feet, of which 6,996,296 feet was unaccounted for. The cost of manufacture was about 1s. 10½d. per 1000 cubic feet. The profit amounted to £6064. There were 1961 stoves in use, 5404 grillers, 2099 prepayment meters, and 95 engines, besides various other apparatus. The Auditors point out that the profits for the preceding twelve months exceeded those of last year by £2419. The chief cause of this decrease was the lower price obtained for residuals, which accounted for £1864. By reason of the renewal of retorts, the cost of production showed an increase of £1144; while the renewal of mains was responsible for an addition of £450 to the outlay on distribution. Among other items, interest on loans and sinking fund charges was £608 more; the total increase being £4275. On the other hand, there was an increase in revenue (including £1796 from gas and meter and stove rentals) of £1852. The total capital expenditure at March 31, 1904, was £288,047; and during the year under review this was increased by £2935.

In moving the confirmation of the Gas Committee's minutes, Alderman Fletcher referred to the profits which had been made during the past three years. On the first occasion that he submitted the annual report the profit was £3858; and that year they decided to reduce the initial price of the gas from 2s. 4d. to 2s. 2d. per 1000 cubic feet, to lower the price for motive power from 2s. 4d. to 2s., and to give 2 cubic feet more gas for 1d. through the prepayment meters. In the following year he had the good fortune to report a profit of £5640; while at the end of last year the profit was £8484. Three years ago their assessment was increased by £3000, which entailed an increase in rates of about £1000 a year. During the past twelve months a number of the retorts had been rebuilt, and the cost paid out of revenue; but notwithstanding this, they had the handsome profit of £6064. The receipts for residuals had been £1864 less than the previous year. It was not proposed to alter the initial price of gas; but by allowances as share of profit and discount for prompt payment, the net price of gas for ordinary purposes would be 1s. 11d., and for motive power 1s. 9d. per 1000 cubic feet. During the past seven years, their output had increased by 77 million cubic feet.

In the course of the subsequent discussion, Mr. Sanderson said he was glad to find the papers were in error in saying the price of gas was

to go up, inasmuch as the initial price was the same and the allowance was 1d. less. Alderman Fletcher: It has not gone up; but it will be 1d. more. Alderman Ashworth advocated a return to the system under which gas was produced and supplied to the consumers at the cheapest possible rate, and there was no attempt to secure large profits. He deprecated the making of huge profits, half of which only were returned to the consumers, the other half being given to the ratepayers in general in relief of rates. He protested against the present system as being economically wrong and unjust to the general population. Mr. Battersby said he was surprised at Alderman Ashworth's remarks, in face of the Borough Treasurer's statement. If they had not had the profit on the gas undertaking, they would have had to face an increase of about another 4d. on the rates. Almost every town made a profit on gas; and in fairness to the ratepayers, who had purchased the works, a profit ought to be made. They bought the water-works; and there was a loss of over £3000 on the Joint Water Board. Was it fair that the ratepayers should bear the loss on one concern, and make no profit on the other? In reply, Alderman Fletcher observed that the initial price of gas remained unaltered; but, as a matter of fact, the cost to the consumer would be 1d. more. As to the profit being extracted from the consumers, he said when they considered the cost of gas to the consumers was less than 2s. per 1000 cubic feet, they would see that the Committee were not, as a matter of fact, extracting too much from them.

The minutes were confirmed.

EXAMINATIONS IN GAS MANUFACTURE.

The Pass List.

The Superintendent of the Department of Technology of the City and Guilds of London Institute (Sir Philip Magnus) has issued the pass list in connection with the last examination in "Gas Manufacture." The following are the names of the successful candidates:—

HONOURS.

First Class.

Ashworth, H.	Collins, R. H.	Ibbotson, S. W.	Philpot, W. C.
Bennet, W.	Cowie, R. W.	King, A. G.	Priestley, A.
Berry, J. H.	Currie, D.	Law, J. K.	Ritchie, H. G.
Booth, W. N.	Game, J. W.	Lister, A.	Roper, J. W.
Bridge, J.	Garsed, E.	M'Crae, J. P.	Sainter, E.
Broadhead, F.	Gill, G. M.	M'Leod, J.	Shaul, W. E.
Brown, T. H.	Grimwood, E. E.	M'Lusky, J. W.	Stones, E. E.
Carpenter, H. J.	Halstead, J. W.	M'Nicholl, J.	Taylor, H. C.
Carpenter, S. A.	Hanson, W.	Meredith, A. J.	Turner, H. R.
Cattle, J. B.	Harrison, H. S.	Newsome, M.	Tyndall, J. F.
Caygill, T.	Hollington, H. G.	Pacey, S. O.	Walmsley, G.
Codgbrook, A. W. C.	Holmes, G. E.	Parrish, P.	Wells, W. W.
	Hoy, H.	Perry, S. T.	Willis, F. C.

Second Class.

Allen, P. T.	Chadderton, F.	Geer, L. J. C.	Stephenson, J.
Barber, C. C.	Clapham, W. A.	Hepburn, J.	Thomas, A.
Brearley, J. W.	Coel, F. C. M.	Hunt, W. D.	Toulson, J. W.
Brown, W.	Cook, R.	Jennings, G. R. M.	Vince, E. P.
Byrom, J.	Darrah, J.	Jones, W. P.	Walker, J. C.
Bywater, J. H.	Easson, W. S.	Robson, J. T.	Walton, W.
Canning, T. F.	Fenner, R. L.	Sanderson, W.	Wilkins, P. S.
Carpenter, W. S.	Fowler, J. F	Saville, F.	Williamson, W. M.
Carr, H. R.	Furniss, T. E.	Somerville, D. A.	Wilson, F.

ORDINARY GRADE.

First Class.

Ablett, E.	Douglas, G. G.	Jonas, W.	Robertson, J. A.
Allan, P.	Durward, E. S.	Jones, E. F.	Robinson, F. J.
Andrews, A. H.	Ellis, R.	Keable, E. F.	Saville, H.
Armitage, C. R.	Evetts, G.	Kirby, S. M.	Sawyer, G.
Bates, W. A.	Galleway, W. M.	Lamprey, R. H. B.	Scott, D.
Blair, W.	Garbutt, W. C.	Lang, J.	Sheridan, J.
Blakey, H.	Gibbs, A.	Leckie, R. B.	Sherret, A.
Brown, P.	Gillespie, J. C. P.	Lofthouse, A. G.	Sismey, W. H.
Cahill, W.	Handley, H. C.	M'Call, J. J.	Sprague, G. T.
Calvert, B.	Harris, C.	M'Geachin, J. G.	Staniforth, H.
Cartwright, W. A.	Harris, S. S.	M'Grath, E. L.	Surtees, R. T.
Chester, W. H. A.	Hatlon, N.	Male, F. J.	Sutton, J. E.
Clark, R. J. H.	Hayes, J. W.	Maud, J.	Topley, W. H.
Clegg, F.	Henderson, S. K.	Nadin, J. G.	Twigg, G. F.
Cockburn, C. R.	Hill, E.	Neill, R.	Watson, W. A. V.
Cooper, J. E. L.	Holt, C. E.	Osborne, A.	Welch, J.
Coppinger, A. D.	Horsfield, A.	Ostler, C.	West, F. A.
Cowie, W. M.	Horsnell, W.	Portass, F.	White, F. H.
Dawson, G. R.	Hoult, H. K.	Pritchard, W. O.	Wright, H.
Deuerdon, R.	Ingham, G.	Quick, A.	Voyce, H. J.
Dixon, H. G.	Jenkins, F. A.	Rann, J. W.	

Second Class.

Allison, E.	Currie, A.	Hart, F. L.	Morley, G. S.
Baigent, W.	Curtis, W. F.	Hepburn, J.	Palmer, W. G.
Balmforth, J. B.	Davis, D. J.	Hornby, P. H.	Pearce, J. E.
Bartholomew, A.	Dean, F.	Jackson, F. T.	Pearson, G. C.
Batten, N. C.	Dean, J. H.	Jonas, J. J.	Simco, W. A.
Bennett, C. V.	De Peyrecave, G.	Jones, I. J.	Simpson, J. T.
Blakeley, G. H.	Drohan, M.	Jones, J.	Smith, B. L.
Blenkinsop, J. P.	England, W.	Lane, G. T.	Smythe, W.
Bolan, C. F.	Gale, J. R.	Leytham, R. G.	Tipping, T. A.
Brown, W. T.	Gentry, J. R.	Lobban, A.	Tylor, H. M.
Burton, W. T.	Ginman, N.	Love, J. R.	Watson, M.
Caldecott, F. W.	Gommersall, W.	Macfarlane, J. B.	Wilby, H.
Carmichael, T.	Green, A. E.	Meunier, E.	Wilson, J.
Colman, J. W.	Grey, A. W.	Monteath, P.	Yorke, E. G.
Cowley W. A.	Griffin, G.		

DEVONPORT CORPORATION GAS UNDERTAKING.

The Past Year's Working.

At the Meeting of the Devonport Town Council last Thursday, the Gas Committee presented their statement of accounts for the year ending the 31st of March last. The capital of the undertaking now stands at £268,238, of which £153,730 was the original cost of the undertaking, including that of the arbitration and transfer. Since then £59,436 has been spent on new works and extensions, and £21,614 on stoves, meters, and automatic installations. Under the local Gas Act and other powers, the Corporation have authority to borrow £296,172 for gas-works purposes; and of this sum £265,937 has been borrowed. Deducting loans repaid and the sum set apart as stock redemption fund, there was on March 31 a balance of loan outstanding of £258,627; and the Committee have unexercised borrowing powers to the amount of £34,177 for the extension of works and £10,090 for meters, stoves, and automatic installations. The capital expenditure works out at £754 12s. 10d. per million cubic feet of gas made, and £7 15s. 2d. per ton of coal carbonized, against £700 14s. 1d. per million and £6 18s. 9d. per ton in the year ending March, 1904.

The make of gas last year was 358,932,000 cubic feet, of which 320,304,625 cubic feet were sold, against 330,529,000 cubic feet made and 305,301,850 cubic feet sold in 1904. Adding the gas supplied free to certain public lamps and that used on the works, there remained last year only 3 9 per cent. unaccounted for, against 6·1 per cent. in 1904. The total revenue of the year was £56,460. Of this sum, £42,279 was from sales of gas, against £39,990 in 1904; the increase in the consumption during the year being 4·9 per cent. and in the income from sales 5·7 per cent. Private consumers took 180,607,200 cubic feet of gas, and paid £22,902; the Government establishments, 62,914,100 cubic feet, for which they paid £6629; prepayment customers, 56,090,325 cubic feet, for which they paid £9270; while for public lighting the consumption was 20,210,000 cubic feet, costing £3476.

The total expenditure on the manufacture and distribution of the gas was £39,721; leaving £16,738 as gross profit. From this sum capital charges amounting to £8276 and depreciation £7299 were deducted; leaving a balance of £1162 to be carried as net profit to the reserve fund. Analysis of the accounts shows that the cost of manufacture was £33,694, which was equal to 1s. 11·412d. per 1000 cubic feet of gas made, against 2s. 0·001d. in 1904. Distribution cost £1763, or 1·016d. per 1000 cubic feet, compared with 0·909d. in 1894. For lighting and repairing public lamps, there was a charge of £1256, equivalent to 0·886d. per 1000 cubic feet, against 0·894d. in 1904. Rents, rates, and taxes amounted to £1289, and showed an increase from 0·794d. to 0·913d. per 1000 cubic feet of gas made. Management cost £1682, or 1·158d. per 1000 cubic feet, compared with 1·162d. The other figures worked out as follows:—

	Per Ton of Coal Carbonized.		Per 1000 Cub. Ft. of Gas Made.		Per 1000 Cub. Ft. of Gas Sold.	
	1905.	1904.	1905.	1904.	1905.	1904.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Gross cost of gas	23 6·311	22 11·823	2 3·455	2 3·832	2 5·051	2 6·132
Less residuals .	7 2·135	6 9·938	0 8·377	0 8·268	0 8·863	0 8·951
	16 4·176	16 1·885	1 7·078	1 7·564	1 8·188	1 9·181
Less rental of meters, &c. .	0 10·201	0 8·534	0 0·992	0 0·861	0 1·050	0 0·932
Net cost of gas .	15 5·975	15 5·351	1 6·086	1 6·703	1 7·138	1 8·249
Gross profit .	10 1·885	8 6·415	0 11·853	0 10·334	1 0·542	0 11·188
Net profit . .	1 8·467	1 2·133	0 0·823	0 1·426	0 0·871	0 1·543

The average cost of coal last year was 14s. 0·15d. per ton, including delivery, against 14s. 5·22d. in 1904. Coke sold at a slightly higher price—9s. 9·39d., against 9s. 8·68d. Tar made only 18s. 5·09d. per ton, compared with 20s. 3·84d.; but sulphate of ammonia averaged £9 3s. 9·40d., against £8 7s. 11·88d. in 1904.

Alderman Hornbrook, the Chairman of the Committee, in moving the adoption of the report, stated that Mr. J. W. Buckley, the new Engineer, had entered on his duties. The profit on the undertaking was slightly larger than that for the preceding financial period. They had had a very expensive year so far as maintenance was concerned; but he believed there was a bright future for the gas undertaking. Mr. Banbury thought the profit ought to have been larger. It was a serious matter that they were paying £3000 a year in interest on capital which was not bringing them in a halfpenny profit. Then the cost of manufacture had gone up; and this also was very serious. When they found that with a larger output the cost of manufacture was greater, it seemed as if the works wanted looking into. Alderman Hornbrook admitted that there was room for improvement, and said he believed improvements would be effected. The report was adopted.

WIGAN CORPORATION GAS UNDERTAKING.

The Past Year's Working.

At the Meeting of the Wigan County Borough Council last Wednesday, Alderman Holmes, in moving the adoption of the minutes of the Gas Committee, said he thought they might congratulate the town on the success which had attended the working of the gas undertaking during the past year, though their profits had not been so great as in the preceding twelve months through the cost of residuals bringing down the amount by £2400. Then there was the increase of over £2000 in the rates paid for the gas-works by reason of the increase in the assessment. Still the net profit from the gas undertaking was £11,282, because, though the profit was put down at £7056, there was the amount of £4226 which was allowed for public lighting. During the past year, 2088 new services had been laid, and 131 had been renewed. He could not compliment the Council on an increase in the consumption of gas, as there was a decrease of something over 3 million cubic

feet on the previous year. Turning to the amount received from the sale of residuals, he said that in the year 1903-4 the cost of coal and cannel was 10s. 8d. per ton, and they received for the residuals from every ton of coal and cannel carbonized the sum of 10s. 10d., or 2d. more than they paid for the coal and cannel. Last year they paid 10s. 1¾d. per ton of coal, and they only derived from the sale of residuals 8s. 10¼d. It is pleasing to see the increase in the consumers of gas; the numbers now being somewhere about 2000 more than before. This showed a general increase in the use and consumption of gas; and he believed that it was being made more popular through the incandescent burner, which gave something like three times as much light as the ordinary burner. Mr. Segrave, in seconding the motion, called attention to a resolution he moved in Committee that the price of gas be reduced 2d. per 1000 cubic feet. He said that whenever they wanted to do anything for the gas consumers they had to fight a very hard battle. Year after year the consumers had not been considered; but on this occasion he did not push his proposition, because he understood that every department of the Corporation had made a sacrifice in order to keep down the rates. For this reason he did not proceed with his resolution. At the same time, he considered that the consumers had a right to participate in the profits of the Gas Department. The motion was carried.

THE OLDEST SERVANT.

Over the well-known initials "G.L.," there appears, in this month's "Co-Partnership Journal of the South Metropolitan Gas Company," the story of the oldest servant of the Company. She entered the service 64 years ago; "she" being a barge with a man's name—"Thomas." Her work is to carry coal, and she is in fact the pioneer barge of the fleet of 122 barges and three tugs now owned by the Company.

Previous to her purchase, "G.L." writes, all coal was brought by hired barges; but the quantity used was under 7000 tons in 1841, or about what is now used at Old Kent Road in one week in the depth of winter. At that time all coal was carried in sailing-ships, generally of not more than 300 tons burden—a 400-ton vessel was rarely seen, and was considered a very big ship, and a 500-tonner never came to us. Freight from the Tyne was from 6s. to 6s. 6d. a ton—quite double the present rate—and voyages took any time up to a month; the ships being often detained for weeks together, and then a fleet of twenty (I think on one occasion as many as thirty) has been known to arrive at the Surrey Dock at one time. They were unloaded by whippers, all hand labour, for 7d. per ton; the men earning good wages. It now costs half as much again—the only case in my experience where the cost has been increased by machinery; but the advantage of machinery is in the saving of time of unloading—100 tons or more an hour against about 100 tons a day by hand labour. If we had now to depend on sailing-ships of (say) 300 tons burden, we should need 4000 cargoes a year, or nearly eighty a week, or about one-and-a-half every working hour throughout the year. The application of the steam-engine to the carriage of coal has enabled the Company to save about 3s. 4d. per ton, or 4d. per 1000 cubic feet on the cost of gas; and this has saved the consumers about £200,000 a year, or (say) £4000 a week. A reduction of 4d. per 1000 feet entitles the shareholders, under the sliding-scale, to ⅓ per cent. more dividend, or about £30,000 a year, and gives the employees under our co-partnership system 3 per cent. extra bonus on salaries and wages, or about £12,000 a year. Moreover, a reduction of 4d. in the price of gas increases consumption, and thereby increases the demand for labour. These lines are taken from a story the reading of which has given much pleasure.

THE ECONOMIC USES OF GAS.

The Gaslight and Coke Company are energetically following up the advantage which they secured of having the great Gas Exhibition of November and December last in their area of supply by lectures and demonstrations in all quarters; the former being delivered by Mr. W. H. Y. Webber, and the latter conducted by Miss Helen Edden. A series was commenced in Chelsea on Monday last week; and the Mayor of Chelsea, appreciating the importance of lectures of this kind, kindly officiated at the opening. His Worship, in the course of his remarks, pointed out that the Gaslight and Coke Company was not, of course, a philanthropic society. It was a business concern, started and carried on for the purpose of making profits. But it was sometimes more than that. It was an important public servant; and on whether it did its duty to the public in an indifferent and disobliging spirit, or in an enterprising and businesslike manner, and with a due sense of its obligations to the citizens residing and trading in the area which it, and it alone, could supply with gas, depended not only the success of the Company but, in no small degree, the comfort and well-being of those citizens. Modern conveniences, like all other good things, were not to be had without some compensating troubles. But while Parliament was undoubtedly wise in giving one Company the sole right to supply gas in the huge area (about 65 square miles) over which the Gaslight and Coke Company operate, it was equally beyond doubt that the granting of that sole right imposed upon the Company the obligation to deal reasonably and in a broad-minded spirit with its consumers. This educational campaign for the purpose of spreading knowledge as to the economic uses of gas was a happy evidence that those responsible for the management of this huge concern realized, to the full, their moral obligations to the public, as well as appreciating their business opportunities. Until a few years ago, the advantages to be derived from having a supply of gas on the premises—for lighting, cooking, or heating as the case might be—could only be enjoyed by those in a position to face and discharge a quarterly gas bill. By the advent of the

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slot meter, and the adoption by the gas companies of the excellent plan of installing in suitable premises, gas pipes, fittings, and cooking stoves at their own first cost—by such simple means, a great social reform had been accomplished. Now a gas supply was available for, as it was essential to the comfort of, all classes of society, from the day-labourer to the King. It was interesting to know, as was the fact, that His Majesty had very complete installations of gas cooking apparatus at Buckingham Palace, at Windsor Castle, and at Sandringham; while, on the other hand, there were no less than 200,000 workers' homes in the district of the Gaslight and Coke Company alone (22,500 of which were in Chelsea and Battersea) supplied with gas on the slot system, and 80 per cent. of the consumers used gas cooking-stoves supplied by the Company. That gas was rapidly growing in popularity for these several purposes was evident from the fact that the Gaslight and Coke Company had already supplied their customers with 247,000 gas cooking-stoves, and 97,000 gas heating-stoves, while gas-engines aggregating 50,000-horse power were in use in their district. The Company now sold 20,000 million cubic feet of gas in a year, and used 2 million tons of coal in making it. Mr. Webber then gave an interesting lecture on the modern developments of gas lighting. The efficiency and economy resulting from the invention of the incandescent mantle was, he pointed out, strikingly illustrated by the fact that the gas-lamps which the Company had fitted temporarily in the hall were giving 2500-candle power for $4\frac{1}{2}$d. per hour, including renewal of mantles; while the electric glow lamps generally used there gave a light of only 750-candle power at an hourly cost for current of over 1s. A demonstration of the economy and convenience of cooking by gas by Miss Edden followed. A hearty vote of thanks, moved by Mr. F. W. Goodenough, the Chief Inspector of the Gaslight and Coke Company, was accorded to the Mayor and Mayoress for the great interest they had evinced in the proceedings.

COMPARATIVE COSTS OF GAS AND ELECTRICITY.

Mr. J. Holliday has been lecturing at Hull; and it is not surprising to find that the "Meteor" of the "Electrical Times" has got entangled with his figures—not because, we think, "Meteor" does not know better, but because he feels it to be his duty to try to make his readers believe that those figures are altogether fallacious. Read this: "Why then do most users of gas still stick to the old and wasteful [flat-flame] burners? The answer seems to be that the incandescent figures are fancy laboratory results, only to be realized even approximately in practice by a lavish expenditure on new mantles. At the late gas exhibition, I believe they were changed daily." We are sure that "Meteor" knows better—though, stay, when we remember what "meteors" are and where they exist, perhaps this one is not quite up to date in his information about mundane matters. However that may be, in his letter to the "Electrical Times" this week, Mr. Holliday "attempts," to use his own word, to account for a 10 to 1 estimate of relative cost. He proceeds—this being the simplest means of tackling the matter—to quote the text of the lecture, and then leaves the matter "to prove itself—or confound itself."

We will now take another side of the efficiency of gas-burners pure and simple; and I would call your attention to the table prepared by Professor Vivian B. Lewes, showing the light emitted per cubic foot of gas consumed per hour by different burners.

Burner.	Candle units.
Incandescent (high pressure)	30 to 38
,, (Kern)	20 ,, 25
,, (ordinary)	14 ,, 19
Regenerative	7 ,, 10
Standard argand	3·20
Ordinary	2·90
Union-jet flat-flame No. 7	2·44
,, ,, ,, 6	2.15
,, ,, ,, 5	1·87
,, ,, ,, 4	1·74
,, ,, ,, 3	1·63
,, ,, ,, 2	1·22
,, ,, ,, 1	0·85
,, ,, ,, 0	0·59

In the Kern burner, we will take the lower figures—20-candle power is developed for a consumption of 1 cubic foot of gas. The consumption of electricity by an ordinary electric incandescent lamp is, on a fair average, 4 watts per candle = to 80 watts per 20-candle-power lamp per hour. Therefore 1 cubic foot of gas will give as much light as 80 watts of electricity. Now in East Hull the cost of 1 cubic foot of gas is equal to $\frac{1}{30}$d. Therefore 1d. will purchase enough gas for 30 incandescent lamps of 20-candle power. The average price of electric current in Hull for lighting purposes we may take as $4\frac{1}{2}$d. per Board of Trade unit. The price of 80 watts of electricity at this rate is just over $\frac{1}{2}$d. Therefore three lamps of this rate of consumption only *can be had for one hour for one penny*. Summarized as in the following table:—

East Hull rates: Electricity $4\frac{1}{2}$d. per B.T.U., Gas 2s. 6d. per 1000 cubic feet.
Gas consumed (Kern burner) . 1 cubic foot.
Candle-power given . . . . 20 standard sperm candles.
Electricity consumed by electric incandescent lamp } 4 watts per candle-power,
or 80 watts for 20 candle-power ∴ the cost of 1 cubic foot of gas = 0·03d., and the cost of 80 watts of electricity = 0·36d. The comparative costs of gas and electricity, *light for light*, by these systems is, briefly, 10 *to* 1 *in favour of gas.*

Extensions at the Burnley Gas-Works.—In consequence of the increasing demands for gas at Burnley, the Gas Committee of the Corporation have decided to anticipate the future by extensions and alterations which will take the best part of twelve months to complete. It is proposed to make application to the Local Government Board for permission to borrow £23,000 for the erection of new gas-making plant. Of this amount, £4980 will be required for a retort-house and £6860 for a new bench, brickwork, and retort ironwork.

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NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The accounts for the year of the Dundee Corporation Gas undertaking were before the Gas Committee and the Finance Committee of the Town Council on Monday. They showed that the quantity of gas sold during the year was 683,618,200 cubic feet; and that the revenue from the sale of gas was £86,294, as compared with £92,088 in the preceding year. The total revenue from all sources was £107,374; and the balance carried to the net revenue account was £24,940. A sum of £10,549 was placed to the sinking fund; and after meeting all charges for interest, &c., there remains a balance of £1204, which is carried forward. For the current year it is estimated that the quantity of gas manufactured will amount to 689,365,000 cubic feet, of which 65,000,000 cubic feet will be carburetted water gas. When the accounts came before the Gas and Finance Committees Mr. G. Stevenson, the Convener of the Gas Committee, moved their approval. The proposal to reduce the price of gas from 2s. 10d. to 2s. 8d. per 1000 cubic feet was agreed to unanimously; but the suggestion to abolish stove-rents met with considerable opposition. Mr. Brownlee and Mr. Spead argued that the proposal ought, in the first place, to have been submitted to the Gas Committee, to the members of which it came as a surprise. It was also argued that it was not a sound commercial transaction, as, while they were reducing the price of gas, the abolition of the stove-rents would tend to increase it. The capital cost of cookers had been £8800, and the annual rental from them was only £519, out of which there had to be paid the cost of maintenance and repair. It was also argued that all the gas consumers did not use stoves; and it was questioned whether it would be legal to benefit one set of ratepayers at the expense of another, apart from the question of responsibility for any loss that might arise from the abolition of the rents. The Town Clerk assured them that there was no legal impediment to the abolition of the rents. In the course of the discussion, it was stated that, with the surplus of £1204, even after abolishing stove-rents, the price of gas could be reduced to the extent of another 1d. per 1000 cubic feet. Ultimately the proposal to abolish stove-rents was defeated. The accounts and the recommendation to reduce the price of gas were then adopted.

In the Dumfries Town Council last week, the Gas Committee recommended that they be authorized to consider and report upon a proposal to procure a new photometer to replace the present one, which is in an unsatisfactory condition. The Manager reported to the Committee that he had had the old gasholder, which was losing gas in large quantity, emptied and shut off; and he recommended that the ironwork of the holder be sold, and the tank filled up, which would give more yard room for the storage of coke. After some discussion, the Council adopted the recommendations of the Committee.

In the Carnoustie Town Council on Monday, Mr. Rae moved, in terms of notice given, that application be made to the Directors of the Carnoustie Gas Company to ascertain on what terms the Company will supply gas to the public lamps during next season, including repairs, upkeep, lighting, &c., or, alternatively, if they will consent to the Gas Manager holding an appointment under the Town Council as Inspector of Lighting for the burgh. He said that the expenditure in recent years had been so heavy that it was time something was done to give better results at less cost. Mr. Walker moved the previous question, and said that if the Council agreed to the motion they would manifest extreme weakness. This was not seconded, and the motion was declared carried.

Mr. J. Lewis, the Inspector of Lighting for the Corporation of Glasgow, has prepared two reports for the Watching and Lighting Committee regarding the charges for the lighting of common stairs. Burners consuming 0·7 cubic foot per hour are charged at the rate of 5s. 9d. each per annum. The next size of burner consumes 1 cubic foot of gas per hour; and the annual charge is 8s. 2½d. each. The total estimated charge for gas is £17,263. To put in burners all over to consume 1 cubic foot per hour, would raise the cost to £24,490—an increase of £7227. If discretion were given to use 1 cubic foot burners in about 18,000 lights, the increased annual cost would be £2214. In Mr. Lewis's opinion, this, with the present candle power of the gas, would be enough to light the stairs sufficiently for ordinary purposes; but, as the Corporation have resolved to reduce the candle power of the gas, he is afraid this may force the adoption of 1-foot burners in all lights, and also materially affect the lighting of private streets and courts—a matter which, in his opinion, requires consideration. Of 10,500 additional lights which were recommended in 1897 to be placed in stairs, there are still about 1316 stairs, requiring about 1430 lights, in which compliance has not yet been made by the proprietors. There are about 750 electric lights in stairs in the city. The proprietors contract direct with the Electricity Committee for current; and a charge of 6s. 6d. per light is made by the Corporation, to cover the cost of labour, &c. The Watching and Lighting Committee recommended that Mr. Lewis be authorized to fit the 18,000 lamps with 1 cubic foot burners, at an increased annual charge of £2214. The recommendation came before the Town Council on Thursday; but in the course of the consideration of it the House was counted out.

The Kirkcudbright Town Council have contracted to purchase 125 tons of top head cannel at 15s. 5d. per ton, and 300 tons of Sanquhar splint at 13s. per ton.

The accounts of the Johnstone Corporation gas undertaking for the past year show a credit balance of £263. It is possible that the price of gas, which is now 2s. 5d. per 1000 cubic feet, may be reduced.

The Pitlochry New Gaslight Company had a revenue in the past year of £1105, and a surplus of £272. A dividend at the rate of 4 per cent. has been paid, and £50 added to the sinking fund. The quantity of gas made during the year was 3,928,700 cubic feet—an increase of 290,000 cubic feet upon the previous year.

A somewhat serious explosion of gas occurred in a public-house at

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LEST YE FORGET.

37 and 45, Saltmarket Street, Glasgow, between seven and eight on Monday morning last. The shop consists of an arch of a railway bridge, which has been closed in by brick walls at front and back, and the roof consists of a wooden ceiling. Painters had been working in the shop for some days, and on this morning two plumbers were lining the ceiling with zinc. Some time ago the gaseliers were removed from the shop; and it is supposed that, following upon this operation, gas had escaped from the service-pipes, and had accumulated in the space between the wooden ceiling and the stonework of the arch. The explosion was caused by one of the plumbers ascending a ladder with a lighted candle. He was knocked to the ground, and was somewhat severely injured. His mate was injured by material falling upon him. A painter was thrown over the counter, and in his passage his foot struck another painter, knocking him down. The front wall of the shop was blown out into the street, and one of the shop attendants along with it. The back wall was also made to bulge out. With all this havoc, it was singular to find that not a vessel containing liquor was disturbed.

It will yet be several months before the new water supply will be brought into Edinburgh, and in the meantime the Water Trustees have issued a notice to householders, stating that, owing to the small storage of water in the reservoirs, it has been found necessary to restrict the supply meantime. The fortnightly statement as to the water in store, issued on Thursday, showed a decrease during the fortnight of 164,906,000 gallons. The delivery of water has been equal to 37·75 gallons per head per day. The rainfall at Glencorse from the 1st of January has been 11·19 inches, as compared with 16·79 inches in the same period of 1904, and 23·23 inches in 1903. At Gladhouse, the rainfall this year has been 10·45 inches, as compared with 14·05 inches and 18·83 inches respectively in the two preceding years,

Quality of Yeovil Water.—A large section of the people of Yeovil are loud in their complaints as to the quality of the water supplied to them by the Corporation. The liquid is yellow in colour, and has a pronounced taste and smell of tar. It is stated that people who used the water have been attacked with illness in consequence. The explanation seems to be that a new supply was connected up with the town mains, and the pipes conveying it from the springs, some miles distant, were not cleansed.

Gas Supply of Chorlton.—Communications have been received by the Manchester Gas Committee from the Chorlton-cum-Hardy Ratepayers' Association and other sources, requesting that steps may be taken to secure the transfer to the Corporation of the supply of gas to inhabitants of Chorlton who are still supplied by the Stretford Gas Company notwithstanding the amalgamation of their locality of residence with the city. Correspondence has already taken place on the subject between the Committee and the Company without the prospect of any satisfactory arrangement being effected. The Committee have now promised to give the matter further consideration.

CURRENT SALES OF GAS PRODUCTS.

Week ending June 10.

The London pitch market is practically unchanged, except that the outlook has been improved through the disappearance of stocks for prompt delivery, the same having now been sold. Transactions are reported in 90 per cent. benzol at 9d. net, and in 90 per cent. toluol at 8d. net, both for early delivery; while 1s. 10d. net has been paid for 60's crude carbolic acid. Crystals are also firm. A good business is being done in solvent naphtha at advancing prices. Sulphate of ammonia remains steady. Makers quote £12 17s. 6d. on Beckton terms, and buyers would pay a shade under this figure.

LIVERPOOL, *June 9.*

Sulphate of Ammonia.

The situation remains practically unchanged. The May export figures show a substantial increase upon those for May, 1904, and, there being considerable inquiry for June with only current production to draw upon, prices have, on the whole, been maintained. The closing quotations are £12 10s. per ton f.o.b. Hull, and £12 16s. 3d. to £12 17s. 6d. per ton f.o.b. Liverpool and Leith. There has been good inquiry for near months, but the firmness of makers tends to check business. For July-December, £12 12s. 6d. per ton is probably nearest value, and £12 10s. for October-March.

Nitrate of Soda.

This article is quiet at 11s. to 11s. 3d. per cwt. on spot.

LONDON, *June 9.*

Tar Products.

There has been rather more business doing during the past week, and in some instances prices show signs of improvement. Some quantity of 90 per cent. benzol was sold in the North of England for home consumption at a price equal to 8¾d. per gallon f.o.b.; while, so far as the London market is concerned, 9d. is reported to have again been paid. Makers here appear to be cleared out of stock, and have nothing to spare for June; while for July, the value may be taken as about 9d. In 50-90 per cent., business has been done at 8½d for June-July; and this price is reported to have again been declined for forward delivery. There is very little at present offering in toluol, so that it is very difficult to fix the price, but it may be taken to be from 8d. to 8¼d. for early delivery. In solvent naphtha, the position remains the same. There is a fairly good business doing for home consumption; but so far as the ordinary quality is concerned, prices do not show signs of improvement. There is, however, a very strong demand for the special heavy qualities; and it seems quite likely that prices will be better in future, as makers have cleared out their stocks and very little will be produced for some time to come. Regarding anthracene, there is absolutely nothing fresh to advise, as neither buyers nor sellers appear

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at present desirous of doing business for either prompt or forward delivery. There is still a fairly good demand for creosote in Yorkshire, but several small sales have taken place at low prices; 1¼d. to 1⅜d. having been accepted in some instances. The larger makers are, however, still firm in their ideas, and decline to consider business at under 1 7/16d. for fine quality oil. In London, no business of importance has taken place; the largest manufacturers being evidently quite willing to wait for the expected American demand. There are, however, several small parcels offering of very saltly oil for which low prices would undoubtedly be accepted; but consumers do not appear at all anxious to take this inferior quality just at present. In carbolic acid, there has been a small business doing during the past week; and in one or two instances 1s. 9½d. has been paid for delivery at outports, while 1s. 9⅝d. was declined for June-July delivery f.o.b. London. There is no actual business doing for July-December; but there are several inquiries over this period. Makers, however, as a rule quote 1s. 10d., and in some instances ask 2s. In crystals, the inquiries are still very good; but business does not appear to have resulted to any appreciable extent. Pitch is very quiet. It is quite evident that some of the larger London makers are very anxious to sell for early delivery judging by the tactics which have lately been pursued. There are undoubtedly sellers at 30s.; and it is reported that one of the largest producers has accepted a price for delivery on the Continent which will certainly work out at considerably under this figure. There is very little offering in the Yorkshire district; makers appearing to be well sold for early delivery, and at present they do not care to offer forward owing to the uncertainty which prevails as to the future of the tar contracts. In the Lancashire district there are still several parcels offering for early delivery at low prices, but consumers do not seem at all anxious to take same. In South Wales, there is very little doing, and sales are reported at low prices for July-September delivery. In Belgium, there has undoubtedly been a little more business doing during the past week, but very low prices indeed have been accepted both for prompt and forward delivery.

The average values during the week were: Tar, 17s. to 21s. 6d. Pitch, London, 29s. to 30s.; east coast, 28s. 6d. to 29s.; west coast, 27s. to 27s. 6d. Benzol, 90 per cent., 9d.; 50-90 per cent., 8½d. Toluol, 8½d. Crude naphtha, 3d. to 3½d.; solvent naphtha, 8½d. to 8½d.; heavy naphtha, 10d. to 10½d. Creosote, London, 1½d. to 1⅝d; North, 1¼d. to 1⅜d. Heavy oils, 2d. to 2¼d. Carbolic acid, 60 per cent., 1s. 9¼d. to 1s. 9½d. Refined naphthalene, £4 to £8; salts, 12s. 6d. to 14s. Anthracene, "A" quality, 1½d. to 1⅝d.; "B" quality, unsaleable.

Sulphate of Ammonia.

The market is quiet, and there has not been much business doing during the past week. Beckton still quote £12 16s. 3d.; but there are no buyers at this price, although at £12 15s. business might be possible for prompt delivery. For July-December, the nominal price is £12 12s. 6d., but buyers are not at present prepared to pay more than about £12 10s. for this period. In Hull, the price remains nominally £12 10s.; but it is reported that a parcel was actually sold at £12 8s. 9d. for early delivery. There is no business to report at Leith; but the value for June shipment may be taken as £12 15s., with a very quiet market.

COAL TRADE REPORTS.

Lancashire Coal Trade.

The only contract given by the Manchester Corporation on Wednesday for cannel was for 2000 tons. Tenders for coal have also been placed among several collieries. The Salford Corporation have accepted a further contract for another 5000 tons of coal. Lancashire boroughs are placing contracts for coal and cannel generally at the present time; and advantage is taken by many manufacturing firms to secure contracts at current rates. This is the chief business in the Lancashire coal market at present. There is no prospect of coal being any cheaper; and users of large quantities do not hesitate to place orders. Prices have not changed since our latest published quotations. Some of the gas-coal contracts have been renewed at last year's price. Full time is being worked at the pits.

Northern Coal Trade.

As often happens before the holidays, there have been very heavy shipments of coal, so that the collieries have been more active, and in some instances the range of prices has been higher. Best Northumbrian steam coals are about 9s. 6d. per ton f.o.b., second-class 8s. 3d. to 8s. 6d., and steam smalls from 4s. 9d. to 5s. 6d. In the gas coal trade, there is no alteration of any moment in price; the quotation for occasional cargoes being from 7s. 9d. to 8s. 3d. per ton f.o.b. for good Durham gas coals. The results of some of the Continental contracts have been disappointing of late, though a few lots of local coals have been sold. In one or two cases the cheaper German quality has been preferred—a result attributed by some to the addition made to the cost of Durham coal abroad by the tax. In coke, the market is firm; and this and the limited production of gas coke makes the latter steadier in price. Fair gas coke is from 12s. per ton f.o.b.

Scotch Coal Trade.

Trade is not improving. Except for the best qualities, the demand is poor. Colliery owners are in many instances complaining that they are working at a loss, and are expressing the view that, unless they are able to get higher prices, they must find relief in a reduction of wages. What business there is going is being very keenly looked after. The prices quoted are: Main 7s. 3d. to 7s. 6d. per ton f.o.b. Glasgow, ell 8s. to 9s., and splint 8s. 3d. to 8s. 6d. The shipments for the week amounted to 243,262 tons—a decrease of 2632 tons upon the previous week, and of 15,922 tons upon the corresponding week of last year. For the year to date, the total shipments have been 4,829,179 tons—an increase of 317,060 tons upon the same period of 1904.

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BLACKBURN	1,250,000	ST. CATHERINES (Remodelled)	250,000	TONBRIDGE	300,000
WINDSOR ST. WORKS, BIRMINGHAM	2,000,000	KINGSTON, PA.	125,000	STRETFORD	500,000
SALTLEY WORKS, BIRMINGHAM	2,000,000	PETERBOROUGH, ONT.	250,000	OLDBURY	300,000
COLCHESTER	300,000	WILKESBARRE, PA.	750,000	TODMORDEN	500,000
BIRKENHEAD	2,250,000	ST. CATHERINES (2nd Cont.)	250,000	SALTLEY, BIRMINGHAM (Third Contract)	2,000,000
SWINDON (New Swindon Gas Co.)	120,000	BUFFALO, N.Y.	2,000,000	YORK (Second Contract)	750,000
SALTLEY, BIRMINGHAM (Second Contract)	2,000,000	COLCHESTER (Second Contract)	300,000	ROCHESTER (Second Contract)	500,000
WINDSOR ST., BIRMINGHAM (Second Contract)	2,000,000	YORK	750,000	NEWPORT (MON.)	250,000
HALIFAX	1,000,000	ROCHESTER	500,000	TOKIO, JAPAN	1,000,000
TORONTO	250,000	KINGSTON, ONT.	300,000	PERNAMBUCO (Brazil)	125,000
OTTAWA	250,000	CRYSTAL PALACE DISTRICT	2,000,000	MALTON	150,000
LINDSAY (Remodelled)	125,000	DULUTH, MINN.	300,000	DULUTH, MINN. (2nd Cont.)	300,000
MONTREAL	500,000	CATERHAM	150,000	BROCKVILLE (ONT.)	250,000
TORONTO (Second Contract Remodelled)	2,000,000	LEICESTER	2,000,000	SMETHWICK	500,000
BELLEVILLE	250,000	ENSCHEDE (HOLLAND)	150,000	GRAVESEND	300,000
OTTAWA (Second Contract)	250,000	BUENOS AYRES (RIVER PLATE CO.)	700,000	NEWPORT MON. (Second Contract)	250,000
BRANTFORD (Remodelled)	200,000	BURNLEY	1,500,000	TORONTO (Third Contract)	750,000
		KINGSTON-ON-THAMES	1,750,000	TORONTO (Fourth Contract)	1,000,000
		ACCRINGTON	500,000	MONTREAL, ONT. (2nd Cont.)	1,800,000
				HAMILTON, ONT.	400,000

LEEDS, 1,800,000 C. Ft. LEICESTER (2nd Cont.), 1,000,000 C. Ft. NEWCASTLE-ON-TYNE, 1,800,000 C. Ft.

AND IN ADDITION, 7,900,000 CUBIC FEET DAILY; also Coal-Gas Plants at NELSON, B.C., CHATHAM, BERLIN, NAPANEE, OWEN SOUND, CALGARY, and WINNIPEG.

TRADE NOTE.

The Jager System of Purification at Sheffield.

We learn that the Sheffield United Gas Company have instructed Messrs. S. Cutler and Sons, of Millwall, the sole licensees of the Jäger system, to fit up a purifier 62 feet long by 20 feet wide on that system at their Neepsend station.

Gas Boycotted at Saintes.—According to a Dalziel telegram, a novel strike has begun at Saintes, a town in the south-west of France. To protest against the abuse of their monopoly by the local Gas Company, the inhabitants decided to discontinue the use of gas for lighting and cooking purposes until the Company consented to redress their grievances. All the shops, *cafés*, offices, hotels, and private residences are now lighted by lamps or acetylene.

Suggested Combination of Coal Buyers.—A suggestion was made by one of the members at the last meeting of the Stoke Town Council that the Gas Committees of neighbouring authorities should be asked to come together with a view to getting their gas coal on better terms from the contractors than at present. He said the Gas Committee had to meet a combination among the contractors. The prices sent in were practically the same; and he thought all the Gas Committees of the district would be able to get better terms by combining. Alderman Geen remarked that this proposal was carried out, partially or in its entirety, years ago; but it did not stand the test of time. There was an arrangement with the local Gas Committees to buy their coals, if possible, at the same price. But some Committees thought that they should not pay the same price as others with less facilities for handling the coal. Now the different Committees made the best terms they could for themselves. The price paid by Stoke compared favourably with that paid by other Committees in the district.

Burslem Corporation Gas Supply.—At the meeting of the Burslem Town Council last Thursday, Mr. S. Johnson, as Chairman of the Gas Committee, submitted his annual report on the gas undertaking, which he said was in a flourishing state. There had been a slight decrease in the output of gas; but the quantity obtained per ton of coal carbonized had increased from 10,261 to 10,964 cubic feet, the result chiefly of the experiments made by the Engineer (Mr. H. Peaty) in the retort-house. The gross profits on the year's working amounted to £10,509; and, after the necessary payments of interest, the contribution to the sinking fund, &c., had been made, there was left a net profit of £3536—a very handsome sum as compared with last year's profit of £127. Since the gas-works were acquired by the Corporation, £52,600 had been paid towards the relief of the rates; but this year no contribution would be made, as there was an overdraft at the bank, and it was desired to create a working balance of at least £2000, while provision would have to be made for a loss of £1200 or £1400 through depreciation in value of the Corporation's Consols. The total expenditure on the gas-works during the year was £25,899, while the income was £36,409. He thought the general result of the year's working was one of which the Gas Committee and the Council might well feel proud, and on which they might congratulate themselves.

Comparisons at West Bromwich.—At Wednesday's meeting of the West Bromwich Town Council, the Chairman of the Gas Committee (Mr. Wilson) presented the annual accounts, which were noticed last week. He remarked that the statement was the most satisfactory one ever presented to the Council, and commented upon the general policy of the Committee during the last few years—viz., to build up the concern out of revenue, and as far as possible make extensions and increase the productive power out of revenue. The loan capital was £206,497, which amount, however, they had reduced by £59,439 handed over to the Borough Treasurer to be placed in the sinking fund. He compared the position of the undertaking that day with what it was in 1882; pointing out that the capital of the concern had been increased during this period by £5606. The capacity of the works had, however, been more than doubled; they had increased the sales of gas by 123 per cent., the meters by 161 per cent., the public lamps by 99 per cent., and the mileage of mains by 48 per cent. For the period under review also the gross profits were £263,439, they had paid in interest £136,677, into the sinking fund £59,499, and in reduction of the general district rate £31,281. The balance had gone to the extensions and improvements of the works. The accounts were approved; the officials being complimented upon the efficiency with which the affairs of the department had been managed.

Depth of Gas-Mains in Wandsworth.—Under section 34 of the Wandsworth and Putney Gas Act, 1900, the Gas Company, before putting down mains in new streets laid out but not taken over, are required to give three days' notice to the Borough Council, who must within 48 hours notify to the Company the depth from the surface and the position in the road at which the mains are to be placed. In the event of the Council not giving the notification, the mains may be laid as the Company think fit. On the 18th of January, the Council decided that mains under the carriageways should be laid at a depth not less than 2 ft. 6 in., and under footpaths at not less than 2 feet, from the surface. The Company, however, objected to these depths, and suggested that an agreement should be entered into giving them power to lay mains at such depths as they pleased; but if the depth were less than 2 feet under footpaths and 2 ft. 6 in. under carriageways, the Company should indemnify the Council against all damages arising from leakage from the pipes or explosions of gas occasioned by the use of road-rollers not exceeding 10 tons in weight. The Highways Committee of the Council reported last Tuesday that they did not approve of the proposed agreement, as it would not achieve the objects aimed at when the Council's predecessors obtained the insertion of the clause in the Act. With the view of meeting the Company, however, the Committee had decided that they should be informed that the Council would be willing to agree to mains being laid in new streets at a depth of not less than 2 ft. 6 in. under the carriageways and 1 ft. 6 in. under the footpaths; and that the Company should be asked to adopt these depths when replacing existing or laying new mains.

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COTTAGE LANE, CITY ROAD, LONDON.

BELL BARN ROAD, BIRMINGHAM.

Loughborough Gas Undertaking.—In proposing the adoption of the report of the Gas and Electricity Committee at the last monthly meeting of the Loughborough Town Council, Alderman Bumpus said the profits from the gas undertaking amounted to £6626. This, on the face of it, looked a worse result than the year before; being a reduction of £228 in the profits. But, as a matter of fact, it was more satisfactory than the balance-sheet twelve months ago, taking into account some changes which had been made and other circumstances. The undertaking had to bear a full year's reduction of 2d. per 1000 cubic feet in the price of gas; and, further, the prices for residuals had been very low during the year. These adverse circumstances more than accounted for the deficit of £228, and showed that the working had been on the whole more satisfactory. The Committee only undertook to produce an amount equal to the interest and sinking fund, £6300; but it would be seen that they had done between £320 and £330 better. The growth in the consumption of gas was 3½ per cent., which was practically due to the increase in the number of slot meters. They had now 350 more consumers by this method than they had a year ago, and the number in the aggregate was 1665. This was the outstanding feature in the increased consumption. The Committee desired to place on record their appreciation of the services rendered by the Gas Manager (Mr. E. Onions) and his staff; and he thought the Council should emphasize this. The undertaking had again worked very harmoniously; and it was due to this that he was able to again chronicle a very satisfactory result.

Extension of Water-Gas Plant at Stockport.—At the meeting of the Stockport Town Council last Wednesday, the minutes of the Gas Committee contained a resolution sanctioning the substitution of a set of generators having a capacity of 800,000 cubic feet per day for the present set, equal to 500,000 cubic feet per day, subject to the cost not exceeding £1390, were approved.

Coventry Corporation Water Undertaking.—The statement of accounts of the water undertaking of the Coventry Corporation for the past financial year shows a net profit of £2166, against a profit for the preceding twelve months of £4352. The Water Committee have decided to recommend the Council to pay over the sum of £4000 to the borough fund out of the unappropriated cash balance in hand. The decreased profits are chiefly accounted for by the interest and sinking fund on the loans for the purchase of the part of the North Warwickshire Water Company's undertaking.

Gas v. Electricity in Public Libraries.—In dealing recently with the free library question, the Sandown District Council discussed the subject of the use of gas or electricity for lighting the building. The result was that the Committee's recommendation as to the exclusive use of electric light was negatived, and an amendment passed that the reference and lending departments should be lighted with electricity and the other parts by gas. Similar action has been taken at the Public Library at Southsea, where gas has been reintroduced as an auxiliary for illuminating the entrance hall and staircase.

WANTED, FOR SALE, CONTRACT, &c. ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Situations Vacant.

MANAGER, ENGINEERING WORKS. No. 4406.
MANAGER, GAS, WATER, OR ELECTRICITY WORKS IN INDIA. Mansfield and Sons, Liverpool.

Situation Wanted.

CLERK OR BOOKKEEPER. No. 4398.

Plant, &c., for Sale.

CONDENSER. Redditch Gas Company.
PUMPING MACHINERY. Birmingham Water Department.

Stocks and Shares.

ASCOT GAS COMPANY. June 27.
EAST SURREY WATER COMPANY. June 27.
GRAYS GAS COMPANY. June 20.
GREAT YARMOUTH WATER COMPANY. June 20.
HUNGERFORD GAS COMPANY. June 27.
KINGSTON GAS COMPANY. June 15.
LEATHERHEAD WATER COMPANY. June 22.
LOWESTOFT WATER AND GAS COMPANY. July 4.
MAIDENHEAD GAS COMPANY. June 27.
ROMFORD GAS COMPANY. July 4.
SOHAM GAS COMPANY. June 27.
SOUTHEND WATER COMPANY. June 20.
WHITECHURCH GAS COMPANY. June 27.
WOKING GAS COMPANY. June 27.

TENDERS FOR

Benzol.

WILMSLOW, &c., GAS COMPANY. Tenders by June 16.

Coal and Cannel.

BAKEWELL GAS DEPARTMENT. Tenders by July 1.
BOLTON GAS DEPARTMENT. Tenders by June 29.
CARNARVON GAS DEPARTMENT. Tenders by June 22.
DEVONPORT GAS DEPARTMENT. Tenders by June 17.
EVESHAM GAS DEPARTMENT. Tenders by June 24.
EXMOUTH GAS COMPANY. Tenders by June 30.
KESWICK GAS COMPANY. Tenders by June 17.
KNUTSFORD GAS AND WATER COMPANY. Tenders by June 24.
LANCASTER GAS DEPARTMENT. Tenders by June 16.
MILLOM GAS DEPARTMENT. Tenders by July 4.
NEW MILLS GAS DEPARTMENT. Tenders by June 26.
OSSETT GAS DEPARTMENT. Tenders by June 26.
RHYL GAS DEPARTMENT. Tenders by June 28.
ROTHERHAM GAS DEPARTMENT. Tenders by June 19.
SAFFRON WALDEN GAS AND WATER DEPARTMENT. Tenders by June 26.
SPALDING GAS DEPARTMENT. Tenders by June 20.
TEIGNMOUTH GAS DEPARTMENT. Tenders by June 22.
WORKSOP GAS DEPARTMENT. Tenders by June 19.

Coke.

BURSLEM GAS DEPARTMENT. Tenders by June 19.

Cookers.

WILMSLOW, &c., GAS COMPANY. Tenders by June 26.

Elevating and Conveying Plant and Storage Hopper.

BARRY GAS DEPARTMENT. Tenders by June 23.

General Stores, Oils and Paints, &c.

WILMSLOW, &c., GAS COMPANY. Tenders by June 26.

Lime.

CHORLEY GAS DEPARTMENT. Tenders by June 20.

Meters.

GLASGOW GAS DEPARTMENT. Tenders by June 21.
WILMSLOW, &c. GAS COMPANY. Tenders by June 26.

Oil for Gas Making.

LEEDS GAS DEPARTMENT. Tenders by June 26.

Oxide.

NEW MILLS GAS DEPARTMENT. Tenders by June 26

Roof Extensions, &c.

BARRY GAS DEPARTMENT. Tenders by June 23.

Sulphuric Acid, &c.

CHORLEY GAS DEPARTMENT. Tenders by June 20.

Tar and Liquor, Grease, &c.

BRIERLEY HILL GAS COMPANY. Tenders by June 17.
CHORLEY GAS DEPARTMENT. Tenders by June 20.
CARNARVON GAS DEPARTMENT. Tenders by June 22.
GREAT WESTERN RAILWAY. Tenders by June 27.
HANWELL ASYLUM. Tenders by June 17.
KESWICK GAS COMPANY. Tenders by June 17.
NEW MILLS GAS DEPARTMENT. Tenders by June 26.
READING GAS COMPANY. Tenders by June 26.
WILMSLOW, &c., GAS COMPANY. Tenders by June 26.

GAS COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 792.

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
530,000	10	Apl. 13	10½	Alliance & Dublin 10 p.c.	21—22	..	4 15 5
160,000	10	,,	7½	Do. 7 p.c.	14—15	..	5 0 0
200,000	5	May 12	6½	Bombay, Ltd.	6¾—7	..	4 12 10
140,000	5	,,	6½	Do. New, £4 paid	5—5½	..	4 14 6
50,000	10	Mch. 15	14	Bourne-mouth Gas and Water } 10 p.c. / B 7 p.c. / Pref. 6 p.c.	29½—30½	..	4 11 10
251,810	10	,,	7		16½—17½	..	4 0 0
53,200	10	,,	6		15½—16½	..	3 12 9
380,000	Stk.	Feb. 24	12	Brentford Consolidated	247—252	..	4 15 3
300,000	,,	,,	9	Do. New	185—190	..	4 14 9
50,000	,,	,,	5	Do. 5 p.c. Pref.	127—132	..	3 15 9
206,250	,,	Dec. 15	4	Do. 4 p.c. Deb.	105—108	..	3 14 1
220,000	Stk.	Mch. 15	11	Brighton & Hove Orig.	225—230	..	4 15 8
246,320	,,	,,	8	Do. A. Ord. Stk.	165—170	..	4 14 2
460,000	20	Mch. 30	10	British	40—41	..	4 17 7
100,000	Stk.	Feb. 24	6	Bromley, Ord. 5 p.c.	120—125	+2	4 16 0
165,700	,,	,,	4½	Do. do. 3½ p.c.	90—94	..	4 15 9
500,000	10	May 12	7	Buenos Ayres (New) Ltd.	11¾—12¼	−¼	5 14 3
250,000	Stk.	Dec. 30	4	Do. 4 p.c. Deb.	97—99	..	4 0 10
150,000	20	Mch. 15	8½	Cagliari, Ltd.	25—27	..	6 2 3
100,030	10	May 31	10	Cape Town & Dis., Ltd.	17—17½*	..	5 14 3
100,000	10	Apl. 28	4½	Do. 4½ p.c Pref.	9¾—10¼	..	4 7 10
50,000	50	May 2	6	Do. 6 p.c. 1st Mort.	52—54	..	5 11 1
50,000	Stk.	Dec. 30	4½	Do. 4½ p.c. Deb. Stk.	101—103	..	4 7 5
1,400,000	Stk.	Feb. 24	5⅛	Commercial 4 p.c Stk.	114—117	..	4 8 10
560,000	,,	,,	5	Do. 3½ p.c. do.	111—114	..	4 7 9
450,000	,,	Dec. 15	3	Do. 3 p.c. Deb. Stk.	86—88	..	3 8 2
800,000	Stk.	,,	6¼	Continental Union, Ltd.	111—114	..	5 14 0
200,000	,,	,,	7	Do. 7 p.c Pref.	140—145	..	4 16 7
424,070	Stk.	Feb. 18	5½	Derby Con. Stk.	123—125	..	—
55,000	,,	Jan. 3	4	Do. Deb. Stk.	108—110	..	3 12 9
486,090	10	Jan. 27	11	European, Ltd.	22—23	..	4 15 8
354,060	10	,,	11	Do. £7 10s. paid	15—16	..	5 3 2
15,243,200	Stk.	Feb. 10	4⅛	Gas-light and Coke } 4 p.c. Ord. / 3½ p.c. max. / 4 p.c. Con. Pref. / 3 p.c. Con. Deb.	99½—100½	..	4 7 7
2,600,000	,,	,,	3½		92—94	..	3 14 6
3,709,735	,,	,,	4		109—111	+½	3 12 1
4,193 975	,,	Dec. 15	3		90—92	..	3 5 3
258,740	Stk.	Mch. 15	5	Hastings & St. L. 3½ p.c.	100—103	..	4 17 1
70,000	10	Apl. 28	11	Hongkong & China, Ltd.	17—18	..	6 2 2
3,800,000	Stk.	May 12	10	Imperial Continental	212—215	..	4 13 0
473,600	Stk.	Feb. 10	3½	Do. 3½ p.c. Deb. Red.	96—98	..	3 11 5
175,242	Stk.	Mch. 15	6	Lea Bridge Ord. 5 p.c.	120—125	..	4 16 0
561,000	Stk.	Feb. 24	10	Liverpool United A	223—225	..	4 8 11
718,100	,,	,,	7	Do. do. B	165—167	..	4 3 10

Issue.	Share.	When Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.
306,083	Stk.	Dec. 30	4	L'rpool Unit'd Deb. Stk.	111—113	..	3 10 10
75,000	5	Dec. 15	5	Malta & Medn., Ltd.	4¼—4¾	..	5 5 3
560,000	100	Apl. 1	5	Met. of } 5 p.c. Deb.	101—103	..	4 17 1
250,000	100	,,	4½	Melbourne } 4½ p.c. Deb.	101—103	..	4 17 1
541,920	20	May 31	3½	Monte Video, Ltd.	11—12*	..	5 16 8
1,565,892	Stk.	Feb. 24	4½	Newc'tle & G'tesh'd Con.	109—110	..	4 4 1
406,025	Stk.	Dec. 30	3½	Do. 3½ p.c. Deb.	92—93	..	3 15 3
15,000	10	Feb. 24	10	North Middlesex 10 p.c.	19—20	..	5 0 0
52,940	10	,,	7	Do. 7 p.c.	13—14	..	5 0 0
300,000	Stk.	May 12	8	Oriental, Ltd.	145—148	..	5 8 1
600,000	5	Mch. 30	7	Ottoman, Ltd.	6—6½	..	5 12 0
168,255	Stk.	—	6½	Plym'th & St'house 5 p.c.	—	..	—
398,490	5	Apl. 28	6	Primitiva Ord.	5⅝—6¼	..	4 16 0
796,980	5	Jan. 27	5	Do. 5 p.c. Pref.	5⅛—5⅝	..	4 13 0
488,900	100	June 1	4	Do. 4 p.c. Deb.	95—97*	+1	4 2 6
851,070	10	Apl. 28	7	River Plate Ord.	11¾—12¼	+¼	5 14 3
300,000	Stk.	Dec. 30	4	Do. 4 p.c. Deb.	97—99	..	4 0 10
250,000	10	Apl. 13	7	San Paulo, Ltd.	12¾—13¼	..	5 5 8
70,000	50	Jan. 3	5	Do. 5 p.c. Deb.	52—54	..	4 12 7
135,000	Stk.	Mar. 15	10	Sheffield A	235—237	..	4 4 5
209,984	,,	,,	10	Do. B	235—237	..	4 4 5
523,498	,,	,,	10	Do. C	235—237	..	4 4 5
123,998	Stk.	Mch. 30	5	Shrewsbury Ord. 5 p.c.	107—110	..	4 10 11
70,000	10	May 31	10	South African	15¼—16¾*	..	6 1 3
6,250,000	Stk.	Feb. 10	5½	South Met., 4 p.c. Ord.	128—130	..	4 4 7
1,832,700	,,	Jan. 13	3	Do. 3 p.c. Deb.	90—92	+1	3 5 3
575,020	Stk.	Feb. 24	5⅛	S'th Suburb'n Ord. 5 p.c.	121—124	..	4 8 9
60,000	,,	,,	5	Do. 5 p.c. Pref.	123—128	+1	3 18 2
112,533	,,	Jan. 13	5	Do. 5 p.c. Deb. Stk.	130—135	..	3 14 1
502,310	Stk.	May 12	5	Southampton Ord.	107—110	..	4 10 11
87,950	,,	—	4	Do. 4 p.c. Deb.	—	..	—
120,000	Stk.	Feb. 24	6¼	Tottenham and Edmonton } A 5 p.c. / B 3½ p.c. / 4 p.c. Deb.	125—128	..	4 17 8
338,020	,,	,,	4¼		98—101	..	4 14 1
125,000	,,	Dec. 15	4		107—110	..	3 12 9
182,380	10	,,	8	Tuscan, Ltd.	9¾—10¼	..	7 16 1
149,900	10	Jan. 3	5	Do. 5 p.c. Deb. Red.	102—104	..	4 16 2
30,000	Stk.	Feb. 24	7½	Wands-worth and Putney } A 5 p.c. / B 3½ p.c. / C 3½ p.c. / 3 p.c. Deb. Stk.	163—168	..	4 12 3
255,636	,,	,,	6½		135—140	..	4 9 3
60,000	,,	,,	5 17/20		114—116	..	4 13 6
57,564	,,	Dec. 30	3		82—87	..	3 9 0
745,872	,,	Mch. 15	5	West Ham 5 p.c. Ord.	102—104	..	4 16 2
185,000	,,	,,	5	Do. 5 p.c. Pref.	123—126	..	3 19 4
193,300	,,	Dec. 30	4	Do. 4 p.c. Deb. Stk.	105—110	..	3 12 9

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SATURATORS—See Advt. in next week's issue.

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Address, No. 4398, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

INDIA.
WANTED, an Intelligent Young Man, capable of Taking Charge of Installations of Gas, Water, or Electricity, in all parts of India. Salary to commence at £24 per Month, *plus* Travelling Allowance. Bachelor preferred.
Apply, stating previous Experience, to MANSFIELD AND SONS, LIMITED, 20, Redcross Street, LIVERPOOL.

MANAGER wanted to take entire Control, under the Board, of the Management of a Works employing about 600 hands. Commercial and Practical Experience of Gas, Water, and General Engineering and Contracting necessary.
Apply, by letter, stating Age, Experience and Salary required, to No. 4406, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

OLD Meters Purchased. Wet or Dry, any size, in Truckloads only at per Ton. State quantity.
Also all kinds of Apparatus bought for Cash.
FIRTH BLAKELEY AND CO., Thornhill, DEWSBURY.

FOR Sale, very cheap for immediate disposal, TWO PURIFIERS, 10 ft. by 5 ft. by 4 ft. deep, Complete.
Apply to SAMUEL WHILE AND SON, 60, Queen Victoria Street, LONDON, E.C.

REDDITCH GAS COMPANY.
CONDENSER for Sale (water cooled), faced joints. First-Class Condition. Capacity 250,000 per day.
Particulars, &c., from A. E. LAYTON, Manager.

NEW Gasholder, 40 ft. diameter by 12 ft. deep, with Steel Standards; also new STEEL TANK to contain same.
Write J. WRIGHT, 181, Queen Victoria Street, LONDON, E.C.

GAS PLANT for Sale—I can always offer NEW and SECOND-HAND GAS APPARATUS, including Retorts and Fittings, Condensers, Exhausters, Scrubbers, Washers, Purifiers, Gasholders, Tanks, Valves, Connections, &c. Also a few COMPLETE WORKS. Compare Prices and Particulars before ordering elsewhere.
J. F. BLAKELEY, Gas Engineer, Thornhill, DEWSBURY.

WATER-WORKS PUMPING-ENGINE FOR SALE
MODERN Compound Surface Con- densing PUMPING-ENGINE and WELL-PUMPS for a depth of 200 feet. Engine Cylinders, 25 in. and 54 in. by 5 ft. Stroke; Pump 24 inches diameter.
STEEL RISING MAIN, with lowering Rods and Screws.
Further Particulars and Order to view to be obtained from the SECRETARY, Corporation Water Offices, BIRMINGHAM.

BOROUGH OF OSSETT.
(GAS DEPARTMENT.)

TENDERS FOR COAL.

THE Ossett Corporation Gas Committee are prepared to receive TENDERS for 9500 Tons of Screened GAS COAL for One Year.
Specification and Form of Tender may be had on application to Mr. Arnold E. Mottram, Engineer and Manager.
Tenders, marked "Tender for Coal," to be sent to me, the undersigned, not later than the 26th inst.
W. BROOK,
Town Clerk.
Borough Offices, Ossett,
June 6, 1905.

OXIDE OF IRON.
(NATURAL.)

BALE & CHURCH will be pleased to send Quotations and Samples on application.
SPENT OXIDE PURCHASED.
BALE'S FIRE CEMENT for all Retort and Furnace work.
PAINT for Gasholders, Purifiers, &c.
5, CROOKED LANE, LONDON, E.C.

SULPHURIC ACID.

SPECIALLY prepared for the Manu- facture of SULPHATE OF AMMONIA.
SPENCER, CHAPMAN, AND MESSEL, LIMITED, 36, Mark Lane, LONDON, E.C. Works: SILVERTOWN.
Telegrams: "HYDROCHLORIC, LONDON."
Telephone: 341, AVENUE.

BROTHERTON & CO., LIMITED.
Offices: Commercial Buildings, LEEDS.
Correspondence invited.

JOHN RILEY & SONS, Chemical Manu- facturers, Hapton, near Accrington, are MAKERS of Special SULPHURIC ACID, for Sulphate of Ammonia Making. Highest percentage of Sulphate of Ammonia obtained from the use of this Vitriol, which has now been used for upwards of 50 Years. References given to Gas Companies.

COUNTY BOROUGH OF ROTHERHAM.
THE Corporation invite Tenders for the supply and delivery at the Gas-Works, Frederick Street, Rotherham, of 22,000 Tons of COAL and NUTS, and 2500 Tons of CANNEL, suitable for Gas Manufacturing Purposes.
Specification and Form of Tender can be obtained on application to the Gas Engineer.
Sealed Tenders to be sent to me not later than the 19th inst., endorsed "Tender for Gas Coal."
The Corporation do not bind themselves to accept the lowest or any Tender.
By order,
W. J. BOARD,
Town Clerk.

THE Directors of the Keswick Gas Company invite TENDERS for the supply of 1800 Tons of best screened GAS COAL or NUTS, to be delivered at Keswick Railway Station between the 1st day of July, 1905, and the 30th of June, 1906, in such quantities and at such times as may be required.
Tenders, stating price per ton, endorsed "Tenders for Coal," to be sent to the undersigned not later than the 17th inst.
The Directors do not bind themselves to accept the lowest or any Tender.
No Form of Tender supplied.
J. H. BRODIE, Secretary.
Main Street, Keswick,
June 1, 1905.

THE Directors of the Keswick Gas Company invite TENDERS for their surplus TAR and AMMONIACAL LIQUOR for Twelve Months from the 30th inst. at per ton delivered into Contractors' Tanks at Keswick Railway Station.
Sealed Tenders, endorsed "Tenders for Tar or Liquor," will be received by the undersigned on or before Saturday, the 17th inst., but the Directors do not bind themselves to accept the highest or any Tender.
Forms of Tender are not supplied.
J. H. BRODIE, Secretary.
Main Street, Keswick,
June 1, 1905.

WILMSLOW AND ALDERLEY EDGE GAS COMPANY.
THE Directors of the above Company invite TENDERS for the surplus TAR and the whole of the AMMONIACAL LIQUOR produced at their Works from July 1, 1905, to June 30, 1906.
Estimated quantities: Tar, 250 Tons; Liquor, 500 Tons.
Further Particulars may be had on application to the undersigned.
Sealed Tenders, endorsed "Tar" or "Tar and Liquor," and addressed to W. H. Welsh, Esq., 52, Brown Street, Manchester, must be sent in not later than Monday, the 26th day of June, 1905.
WM. SEVERS,
Engineer and Manager.
Gas-Works, Wilmslow,
May 31, 1905.

WILMSLOW AND ALDERLEY EDGE GAS COMPANY.
THE Directors of the above Company are prepared to receive TENDERS for their requirements as under for the Year ending June 30, 1906.
GAS-METERS (dry), GAS-COOKERS, PAINT, OIL, and BENZOL, delivered at the Company's Works; also for Carting for One, Two, or Three Years.
Particulars as to quantities required, copies of Specification, and Forms of Tender can be had from the undersigned.
Tenders, endorsed "Tender for——," must be delivered to Mr. W. H. Welsh, 52, Brown Street, Manchester, not later than Monday, the 26th day of June, 1905.
The Directors do not bind themselves to accept the lowest or any Tender.
WM. SEVERS,
Engineer and Manager.
Gas-Works, Wilmslow,
June 2, 1905.

ROBERT DEMPSTER & SONS, Ltd.,
Contractor for Complete CARBONIZING PLANTS and every description of GAS APPARATUS and ELEVATING and CONVEYING PLANT, ROSE MOUNT IRON-WORKS, ELLAND.

TENDERS FOR GAS COAL.

THE Spalding Urban District Council invite TENDERS for the supply of 2000 Tons (more or less) of best GAS COAL or NUTS to be delivered free on board in the Tyne or in Tyne Dock, and for the supply of 3000 Tons (more or less) of best GAS COAL or NUTS to be delivered free on board at Goole or Keadby in such quantities and at such times as shall from time to time be required from the month of July, 1905, to the month of July, 1906.

The Council do not bind themselves to accept the lowest or any other Tender.

Tenders, endorsed "Tender for Coal," are to be sent to me on or before Tuesday, the 20th day of June inst.

No Form of Tender supplied.

H. H. HARVEY,
Clerk to the Spalding UrbanDistrict Council.

June 1, 1905.

TENDERS FOR TAR.

THE Gas Committee of the Carnarvon Corporation invite TENDERS for the purchase of the surplus TAR made at their Works during the Twelve Months ending the 31st of August, 1906.

The Tar will be loaded free into Contractor's Tank-Trucks on Rail at the Gas-Works Siding, Carnarvon.

Payments: Net Cash Monthly.

Sealed Tenders, endorsed "Tender for Tar," and addressed to the Chairman of the Gas Committee, Guildhall, Carnarvon, to be delivered on or before Thursday, the 22nd inst.

The Committee do not bind themselves to accept the lowest or any Tender.

Any further Information may be had from the undersigned.

WILLIAM M. RUXTON,
Manager.

Gas Office, Carnarvon,
June 1, 1905.

TENDERS FOR GAS COAL.

THE Gas Committee of the Carnarvon Corporation invite TENDERS for the supply of 3000 Tons of best screened GAS COAL, more or less, and 200 Tons of screened CANNEL, to be delivered free as required, in Trucks on the Gas-Works Siding, Carnarvon, during the Twelve Months ending the 31st of August, 1906.

Sealed Tenders, endorsed "Tender for Coal," and addressed to the Chairman of the Gas Committee, Guildhall, Carnarvon, to be delivered on or before Thursday, the 22nd inst.

The Committee reserve to themselves the right to divide the quantity into two or more Contracts, and do not bind themselves to accept the lowest or any Tender.

Forms of Tender and Specification to be had on application to the undersigned.

WILLIAM M. RUXTON,
Manager.

Gas Office, Carnarvon,
June 1, 1905.

BOROUGH OF CHORLEY.
(GAS DEPARTMENT.)

THE Chorley Corporation invite Tenders for the following:—

1—Purchase of surplus TAR, about 700 Tons.
2—Supply of LUMP LIME, SMALL LIME, or LIME ASHES, 600 Tons or thereabouts.
3—Supply of BRIMSTONE ACID, 100 Tons or thereabouts.
4—Supply of PYRITES ACID, 150 Tons or thereabouts.

For Twelve Months commencing July 1, 1905.

Form of Tender for Acid, or any other Information, may be obtained on application to Mr. J. W. Allin, Gas Engineer, Chorley.

Tenders, duly endorsed, to be delivered to me on or before Tuesday, the 20th of June, 1905.

The Corporation do not bind themselves to accept any Tender.

By order,
JNO. MILLS,
Town Clerk.

Town Hall, Chorley,
June 1, 1905.

NEW MILLS URBAN DISTRICT COUNCIL.

TENDERS FOR GAS COAL, CANNEL, and OXIDE OF IRON.

TENDERS FOR TAR and AMMONIACAL LIQUOR.

COAL.

THE New Mills Urban District Council invite TENDERS for the supply of 2300 Tons of Best Gas Coal and 350 Tons of Cannel, for the Year ending the 30th of June, 1906.

OXIDE OF IRON.

Also for the supply of about 40 Tons of Oxide of Iron, to be delivered at the Midland Railway Station, New Mills.

TAR AND LIQUOR.

Tenders are invited for the surplus Tar and Ammoniacal Liquor produced at their Works from July 1, 1905, to June 30, 1906, to be delivered in purchasers' Tank-Waggons at the Midland Railway Station, New Mills.

Forms of Tender and full Particulars may be had on application to the Gas Manager.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders, endorsed, to be sent to me so as to arrive not later than the 26th day of June, 1905.

By order,
JOSEPH POLLITT,
Clerk.

Town Hall, New Mills,
June 10, 1905.

THE Knutsford Light and Water Company invite TENDERS for about 3000 Tons of best GAS COAL and 300 Tons of CANNEL for the ensuing Twelve Months.

Tenders to be sent in on or before the 24th inst. and addressed to the Chairman of the Company.

The Directors do not bind themselves to accept the lowest or any Tender.

BOROUGH OF SAFFRON WALDEN.

TENDERS FOR COAL.

THE Gas and Water Undertaking Committees of the Town Council are prepared to receive TENDERS for the supply of about 1450 Tons of best Screened GAS COAL, and about 270 Tons of best Hand-Picked Hard STEAM COAL respectively, for the Twelve Months ending the 30th of June, 1906.

Full Particulars can be obtained on application to Mr. A. H. Forbes, Borough Surveyor.

Sealed Tenders, endorsed "Tender for Gas Coal," or "Tender for Steam Coal," as the case may be, to be addressed and sent to me, the undersigned, not later than Five o'clock in the afternoon on Monday, the 26th day of June inst.

The lowest or any Tender will not necessarily be accepted.

W. ADAMS,
Town Clerk.

Saffron Walden, June 7, 1905.

WORKSOP GAS COMPANY.

THE Directors of the Worksop Gas Company are prepared to receive TENDERS for the supply of 4500 Tons of the best screened GAS COAL, delivered at Worksop Station, between the 1st of July next and the 30th of June, 1906, in such quantities and at such periods as may be ordered from time to time. To be free as possible from Sulphur, Bats, Bind, Refuse and Dirt, and shall be weighed (20 cwt. to the Ton) upon the Company's Machine.

Tenders to be sent in to the undersigned on or before the 19th of June, 1905.

No Special Form of Tender provided.

The Directors reserve to themselves the right to accept Tenders for the whole or any portion of the quantity offered, and do not bind themselves to accept the lowest or any Tender.

By order,
F. KENT,
Manager.

June 6, 1905.

BARRY URBAN DISTRICT COUNCIL.

THE above Council invite Tenders for the following—viz:

1—Extension of existing roof over Purifiers.
2—Additional Coal Elevating and Conveying Plant to work in conjunction with the present plant; also extension of Coal Storage Hoppers.

Drawings relating to No. 1 may be seen, and Specification, Quantities, and General Conditions obtained, and outline Plan of No. 2 may be seen and General Conditions obtained at the Office of Mr. F. M. Harris, Engineer, Gas-Works, Barry, on any week day except Saturday, between the hours of Ten a.m. and Four p.m. from June 13 to 21 inclusive, on payment of One Guinea in each case, which will be returned on receipt of a *bonâ-fide* Tender.

Sealed Tenders, endorsed "Tender for Purifier Roof" or "Coal Elevator," as the case may be, must be sent to the undermentioned not later than the 23rd of June, 1905.

The lowest or any Tender not necessarily accepted.

T. B. TORDOFF,
Clerk.

District Council Offices,
Barry, Glam.

EXMOUTH GAS COMPANY.

THE Directors of the Exmouth Gas Company invite TENDERS for the supply of 4500 to 5000 Tons of best GAS COAL (screened or unscreened), to be delivered in such quantities and at such times as may be required from the 1st of August, 1905, to the 31st of July, 1906, and to weigh 20 cwt. to the Ton over the Gas Company's or Dock Company's weighbridge (the said machines are regularly inspected by the Officer under Weight and Measures Act). The Coal to be fresh wrought, dry, and free from Hards, Smudge, Dirt, Shale, and Pyrites.

Tenders to be accompanied by practical working Analysis.

Prices may be quoted c.i.f. or f.o.b. Exmouth Docks (by sailing vessels only), or f.o.r. Exmouth Railway Station (L. & S.W. Railway).

Sealed Tenders, endorsed "Tenders for Coal," to be addressed J. Palmer, Esq., Chairman, and delivered to the undersigned not later than Friday, the 30th day of June, 1905.

The Directors do not bind themselves to accept the lowest or any Tender.

Forms of Tender are not supplied.

JAMES T. FOSTER,
Secretary and Manager.

Gas-Works, Exmouth,
June 6, 1905.

GREAT WESTERN RAILWAY.

THE Directors of this Company are prepared to receive TENDERS for the purchase of—

GAS TAR and AMMONIACAL LIQUOR.
HYDROCARBON from Oil-Gas-Works.
FURNACE SLAG, FETTLING, & MILL SCALE.
TARPAULIN CUTTINGS and SHEET TIES.
DIRTY GREASE.

Forms of Tender (upon which alone Tenders will be received) may be obtained on application to the undersigned, by whom Tenders, marked outside "Tender for Residuals," will be received on or before Tuesday, the 27th of June.

The Directors do not bind themselves to accept the highest or any Tender.

G. K. MILLS,
Secretary.

Paddington Station, London.
June 5, 1905.

BOROUGH OF EVESHAM.
(GAS DEPARTMENT.)

TENDERS FOR GAS COAL.

THE Evesham Corporation invite TENDERS for the supply of from 1000 to 2000 Tons (or less if required) of best screened GAS COAL during the Year ending the 30th day of June, 1906, to be delivered on rail at Evesham.

Tenders (to be marked "Tender for Gas Coal") to be sent to me not later than the 24th day of June inst., and to include full description as to Coal and Price.

No Form of Tender supplied.

The Corporation do not bind themselves to accept the lowest or any Tender.

THOS. A. COX,
Town Clerk.

Town Clerk's Offices,
Evesham, June 8, 1905.

DEVONPORT CORPORATION.
(GAS DEPARTMENT.)

THE Gas Committee of the Devonport Corporation are prepared to receive TENDERS for the supply of 30,000 to 40,000 Tons of COAL, to be delivered during the Year ending the 30th of June, 1906.

The Coal is to be delivered c.i.f. at Tamar Wharf; and Forms of Tender and Specifications may be obtained from the undersigned.

The Committee reserve the right to accept Tenders for the whole or any portion of the quantity offered, and do not bind themselves to accept the lowest or any Tender.

Sealed Tenders, endorsed "Tenders for Coal," and addressed to R. J. Fittall, Esq., Town Clerk, Devonport, are to be delivered at the Town Clerk's Office on or before the 17th day of June, 1905.

By order,
JOSEPH W. BUCKLEY,
Engineer and Manager.

Gas-Works, Devonport.

COUNTY BOROUGH OF BOLTON.
(GAS DEPARTMENT.)

TENDERS FOR COAL.

THE Gas and Lighting Committee invite TENDERS for the supply of screened and unscreened GAS COAL, GAS SLACK, COBBLES, and NUTS, required during the Year ending the 30th of June, 1906.

Specifications and Forms of Tender may be obtained on application to Mr. Wm. Walch, Office Superintendent, Gas Offices, Bolton.

Sealed Tenders, endorsed "Tender for Coal," and addressed to the Chairman of the Committee, to be delivered at the Gas Offices, Bolton, not later than Thursday, the 29th of June, 1905.

SAMUEL PARKER,
Town Clerk, *pro tem.*

Town Hall, Bolton,
June 8, 1905.

RHYL URBAN DISTRICT COUNCIL.

TENDERS FOR COAL.

THE Rhyl Urban District Council are prepared to receive TENDERS for the supply of 5000 Tons of Screened GAS COAL, to be delivered f.o.r. Rhyl during the Twelve Months ending July 31, 1906, in such quantities and at such times as may be required.

Form of Tender and Particulars of Conditions may be obtained on application to Mr. Leonard G. Hall, Assoc.M.Inst.C.E., Gas Engineer.

Sealed Tenders, endorsed "Tenders for Coal," to be delivered to me, the undersigned, not later than the 28th of June, 1905.

Approved security will be required.

The Council do not bind themselves to accept the lowest or any Tender.

ARTHUR ROWLANDS,
Clerk to the Council.

Council Offices, Clwyd Street,
Rhyl, June 5, 1905.

TEIGNMOUTH URBAN DISTRICT COUNCIL.

THE Gas Committee of the above Council invite TENDERS for the supply of 2800 Tons of best Durham or other good GAS COAL, screened or unscreened. Same to be supplied to the requirements of the Council between the 31st day of July, 1905, and the 30th day of June, 1906. The Coal must be fresh-wrought, and free from all impurities.

No special Tender Form will be issued.

Tenders must be accompanied by a full description and practical working Analysis of the Coals quoted, and may be f.o.b., c.i.f., Teignmouth Harbour, or f.o.r., Teignmouth Railway Station.

Sealed Tenders, endorsed "Gas Coals," to be sent to the undersigned not later than Thursday, the 22nd day of June, 1905.

The Committee do not bind themselves to accept the lowest or any Tender.

By order,
J. ALEX. GRAY,
Gas Manager.

LONDON COUNTY ASYLUM, HANWELL, W.

THE Sub-Committee for the Control and Management of the above-named Asylum are prepared to receive OFFERS for the purchase of TAR and AMMONIACAL LIQUOR for Twelve Months ending June 30, 1906.

Terms: Cash on removal.

Forms of Tender, with estimated quantities for sale, may be obtained on application to the Resident Engineer at the Asylum.

Tenders must be sent, in sealed covers, endorsed "Tender for Tar and Liquor, Hanwell Asylum," to the undersigned by or before Ten o'clock a.m. on Saturday, the 17th of June, 1905.

The Sub-Committee do not bind themselves to accept the highest or any Tender.

H. F. KEENE,
Clerk of the Asylums Committee.

London Asylum Committee Office,
6, Waterloo Place, London, S.W.
June 7, 1905.

BAKEWELL URBAN DISTRICT COUNCIL.

TENDERS are invited for the supply of 1200 to 1400 Tons of GAS COAL and 100 Tons CANNEL for One Year ending the 30th of June, 1906, delivered at Bakewell Station (Midland).

Forms of Tender and Particulars can be obtained from the undersigned, to whom Tenders must be sent by the 1st of July.

The lowest or any Tender will not necessarily be accepted.

V. R. COCKERTON,
Clerk.

Bakewell.

LEEDS CORPORATION GAS-WORKS.

THE Gas Committee are prepared to receive TENDERS for the supply of GAS OIL for the Manufacture of Carburetted Water Gas, for a period of One Year, commencing on the 1st of September next.

Specification and Conditions of Tender may be obtained on application to the undersigned.

Tenders and Samples, addressed to the Chairman of the Gas Committee, and endorsed "Gas Oil," must be delivered at the Gas Offices, East Parade, Leeds, on or before Monday, the 26th inst.

The Committee do not bind themselves to accept the lowest or any Tender.

R. H. TOWNSLEY,
General Manager.

Gas Offices, East Parade,
Leeds, June 10, 1905.

MILLOM URBAN DISTRICT COUNCIL.

TENDERS are invited for the supply of 1200 to 2500 Tons of GAS COAL at such times and in such quantities as the Council may require during Twelve Months from the 1st of August next.

The Coal must be of the best quality.

Full Particulars of the Coal, Colliery, and Working Analysis to be given.

State price per Ton delivered free at Millom Station (Furness Railway).

Sealed Tenders, on Forms which can be had on application, endorsed "Tender for Coal," to be sent in to me not later than the 4th of July prox.

The Council will not be bound to accept the lowest or any Tender.

W. T. LAWRENCE,
Clerk.

Millom, June 5, 1905.

BURSLEM CORPORATION GAS COMMITTEE.

TENDERS FOR COKE.

THE Gas Committee invite Tenders for the surplus COKE (about 8000 Tons), loaded into buyers' Trucks at Longport, Staffs., from June 30, 1905, to June 30, 1906.

Tenders, endorsed "Coke," to be addressed to the Chairman of the Gas Committee, Gas-Works, Longport, Staffs., and delivered not later than Monday, the 19th of this month.

HENRY PEATY,
Engineer and Manager.

READING GAS COMPANY.

THE Directors of the Reading Gas Company invite TENDERS for the purchase of their surplus TAR for One Year, commencing on the 1st of July next.

Specifications for the Contract will be forwarded on application to the Engineer and Manager, Mr. Douglas H. Helps, Assoc.M.Inst.C.E.

Under the Conditions of the Contract, no allowance will be made for any water which may be found in the Tar.

Railway communication direct to the works.

Tenders, endorsed "Tender for Tar," and addressed to the undersigned, must be delivered not later than Monday, June 26, 1905.

A. CANNING WILLIAMS,
Secretary.

159, Friar Street, Reading,
June 6, 1905.

GLASGOW CORPORATION.
(GAS DEPARTMENT.)

THE Corporation invite Tenders for the supply of such PREPAYMENT METERS as may be required by them for Twelve Months from the date of acceptance.

Forms of Tender may be obtained on application to Mr. Alexander Wilson, the Manager, at his Office, 45, John Street, Glasgow, and sealed Offers, marked "Gas Department—Tender for Prepayment Meters," addressed to the Subscriber, will be received by him not later than Ten a.m. on Wednesday, the 21st curt.

The Corporation do not bind themselves to accept the lowest or any Offer.

JOHN BOWERS,
Town Clerk.

City Chambers, Glasgow,
June 8, 1905.

CORPORATION OF LANCASTER.
(GAS DEPARTMENT.)

TENDERS FOR GAS COAL.

THE Gas Committee are prepared to receive TENDERS for the supply of GAS NUTS, to be delivered on the Gas-Works' Siding, Lancaster, in such quantities and at such times as may be required during a period of Twelve Months commencing delivery August 1 next.

Sealed Tenders, endorsed "Gas Coal," giving full Particulars of the coal offered, must be delivered to T. C. Hughes, Esq., Town Clerk, Lancaster, on or before Friday, June 16.

Any further Information, and Forms of Tender may be obtained on application to the undersigned.

C. ARMITAGE,
Manager.

Gas-Works, Lancaster.

ISSUES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MR. ALFRED RICHARDS begs to notify that his ISSUES by AUCTION under PARLIAMENTARY POWERS of STOCKS and SHARES in LONDON, SUBURBAN, and PROVINCIAL GAS and WATER COMPANIES take place PERIODICALLY at the Mart, TOKENHOUSE YARD, E.C.

Terms for Issuing such Capital, and also for including in Gas and Water Stocks and Shares belonging to Private Owners in these Periodical Sales, can be obtained on application at MR. ALFRED RICHARDS' OFFICES, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
GRAYS GAS COMPANY, LIMITED.

NEW ISSUE OF 600 £10 "B" SHARES.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, June 20, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
SOUTHEND WATER-WORKS COMPANY.

NEW ISSUE OF 2100 NEW ORDINARY FIVE PER CENT. MAXIMUM £10 SHARES.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, Tokenhouse Yard, E.C., on Tuesday, June 20, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
GREAT YARMOUTH WATER-WORKS COMPANY.

NEW ISSUE OF 200 £10 ORDINARY SHARES AND £3000 FOUR PER CENT. PERPETUAL DEBENTURE STOCK.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, June 20, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
MAIDENHEAD GAS COMPANY.

NEW ISSUE OF £4000 ADDITIONAL CONSOLIDATED ORDINARY STOCK.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C. on Tuesday, June 27, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
WOKING DISTRICT GAS COMPANY, LIMITED.

NEW ISSUE OF 760 £5 SHARES.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, June 27, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

WATER AND GAS SHARES
IN THE
EAST SURREY WATER COMPANY.
ASCOT DISTRICT GAS COMPANY.
WHITCHURCH AND DISTRICT (HANTS) GAS COMPANY, LIMITED,
HUNGERFORD GAS COMPANY, LIMITED.
SOHAM GAS COMPANY, LIMITED.
TO BE SOLD BY AUCTION, BY

MR. ALFRED RICHARDS, at the Mart, E.C., on Tuesday, June 27, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
ROMFORD GAS AND COKE COMPANY, LIMITED.

NEW ISSUE OF 1000 £5 "B" SHARES.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, July 4, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
LOWESTOFT WATER AND GAS COMPANY.

NEW ISSUE OF 400 ADDITIONAL ORDINARY £10 SHARES,

Ranking for a Maximum Dividend of 7 per cent., previous Issues of similar Shares now receiving 5¼ per cent.; also

£1000 FOUR PER CENT. PERPETUAL DEBENTURE STOCK.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, July 4, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

BRIERLEY HILL DISTRICT GASLIGHT COMPANY.

TENDERS FOR TAR.

THE Directors invite Offers for the surplus TAR made at their Brierley Hill and Kingswinford Works, to be taken between July 1 next and June 30, 1906, delivered into Buyers' Boats. Tenders to be at the rate of 200 Gallons to the Ton.

The Directors do not bind themselves to accept the highest or any Tender.

Tenders to be addressed to the Chairman, endorsed "Tender for surplus Tar," not later than June 17 next.

HENRY M. JACKSON,
Secretary.

Board-Room, Gas-Works,
Brierley Hill, May 29, 1905.

By order of the Directors of the
KINGSTON-ON-THAMES GAS COMPANY.

NEW ISSUE OF £10,000 CONSOLIDATED ORDINARY STOCK.

SUDLOW HERRICK & SONS will Sell THE ABOVE BY AUCTION, in Lots, at the Kingston Hotel, opposite the Station, Kingston-on-Thames, on

Thursday, June 15, 1905,
at Five o'clock.

Particulars of the AUCTIONEERS, 90, Eden Street, Kingston-on-Thames; or of Mr. S. C. SHERRARD, Secretary, Gas Offices, KINGSTON-ON-THAMES.

LEATHERHEAD AND DISTRICT WATER-WORKS COMPANY.

NOTICE is Hereby Given of Sale by TENDER of 400 SHARES of £10 EACH (with dividend thereon limited to 7 per cent.) being a portion of the Additional Share Capital authorized to be raised by a Resolution passed at the General Meeting of Proprietors held on the 29th of October, 1903, in pursuance of the powers of "The Leatherhead and District Water Order, 1903."

No Tender will be received after Eleven a.m. on Thursday, June 22, 1905, nor below £14 per Share.

Form of Tender can be obtained on application to the Secretary.

By order,
JOHN YOUNG,
Secretary.

North Street,
Leatherhead,
May 31, 1905.

TOTTENHAM AND EDMONTON GASLIGHT AND COKE COMPANY.

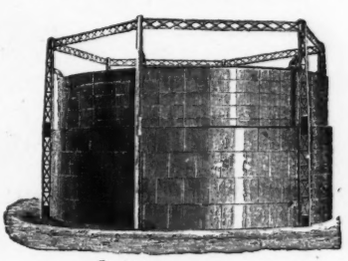
NOTICE is Hereby Given, that the TRANSFER BOOKS of the Company, so far as they relate to DEBENTURE STOCK, WILL BE CLOSED at Ten o'clock forenoon on Friday, the 16th of June, for the Half Year ending the 30th of June, 1905, and will be RE-OPENED on Friday, the 23rd of June.

The Interest for the Half Year will be payable on the 1st day of July next to the Proprietors registered on the closing of the Books.

By order of the Board,
JAMES RANDALL,
Secretary.

Chief Offices: 639, High Road,
Tottenham, June 9, 1905.

J. FIRTH BLAKELEY & Co
THORNHILL,
DEWSBURY.



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References and Catalogues on application.

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The very best Patent Grid on the Market for Holding Oxide Lightly,

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No Extra Cost in adopting this system to existing Purifiers.

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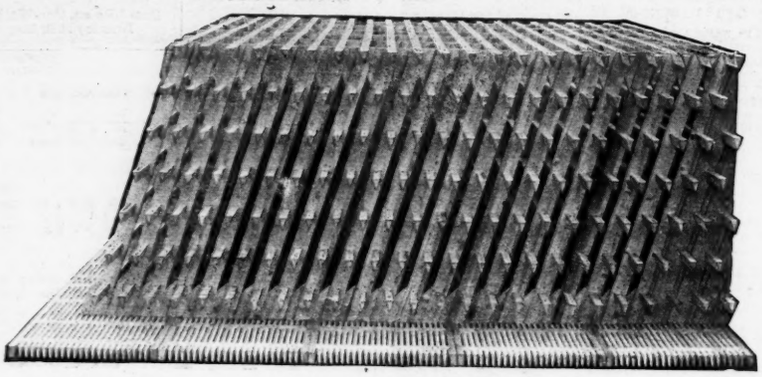

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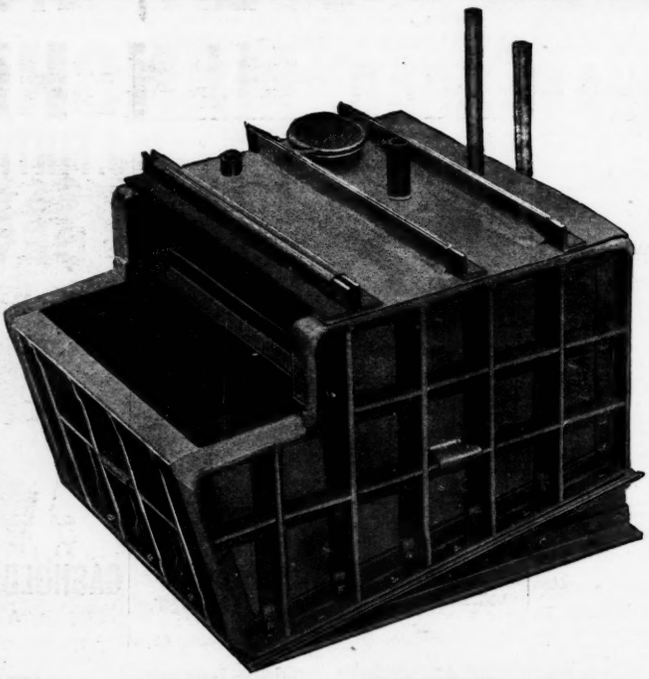

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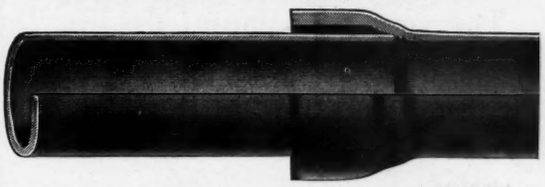

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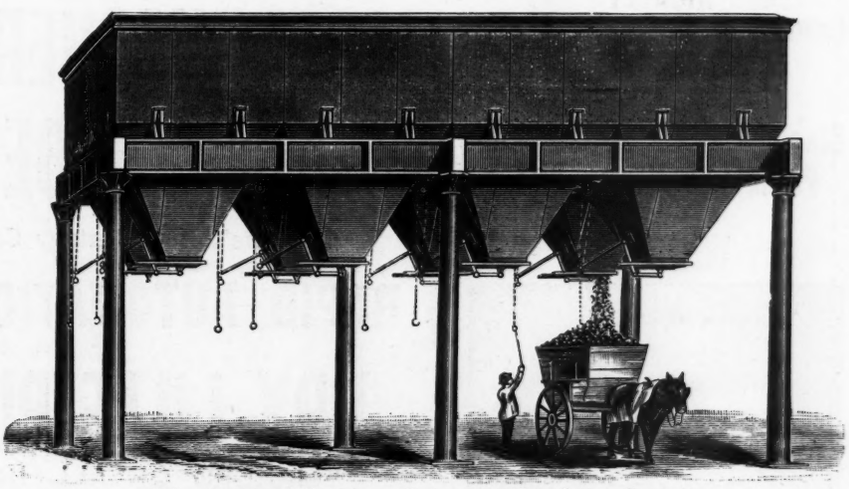

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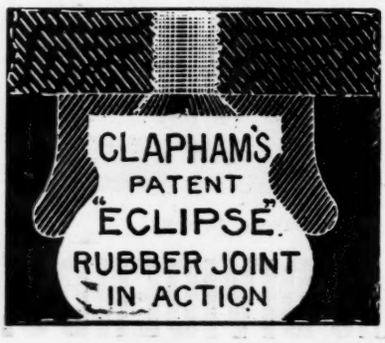
Clapham's Patent **"ECLIPSE" WATER-TUBE CONDENSER**

Clapham's New Century Cover, with Patent



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Printed for WALTER KING by King, Sell, & Olding, Ltd.; and published by him at 11, BOLT COURT, FLEET STREET, in the CITY OF LONDON.—Tuesday, June 13, 1905.